Effects of an intervention to promote fruit and vegetable consumption among schoolchildren

Efeitos de um programa de intervenção para promover o consumo de fruta e hortícolas em crianças em idade escolar

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Abstract

Consumption of sufficient amounts of fruit and vegetables may contribute to the prevention of several chronic diseases. Nevertheless, most children in Western countries, including Portugal, do not comply with recommendations for fruit and vegetable intake.

One recommended setting for promoting children’s fruit and vegetable consumption on a population-wide basis is school. Consequently, a number of programs have been developed for implementation in schools addressing potential determinants of fruit and vegetable intake. However, much of the literature has focused on highly developed interventions that were not designed taking into account socioeconomic, geographic and cultural characteristics of the different populations.

The present thesis is part of the European Pro Greens project and aims to evaluate the Pro Greens intervention in Portuguese schoolchildren, namely through the assessment of the differences in fruit and vegetable consumption and its determinants. Furthermore, after follow-up we aimed to listen to the participants’ views using qualitative research methods.

A convenience sample of 11-13 year old schoolchildren, from 5 primary state schools in the North region of Portugal was selected for this study. 2 of the 5 schools were randomly assigned to intervention. Core determinants and intervention elements were carefully chosen and arranged in three major components: classroom, school and family.

Children from control and intervention schools completed a self-administered questionnaire to assess fruit and vegetable intake and their determinants in May 2009 and again in May 2010, after the intervention has been completed.

A total of 690 children completed the questionnaire both at baseline and follow-up period.

Later, focus groups were carried out with former participants of the Pro Greens intervention to examine their perceptions of the program and suggestions for the design of future interventions.
Total fruit and vegetable consumption has significantly increased in the intervention group compared with the control group. Both for fruit and vegetables, knowledge about recommended levels, to bring fruit / vegetables to school and perceived availability at home revealed a significant higher evolution in the intervention group. The strongest determinants of higher evolution on fruit intake both for control and intervention schools were lower baseline intake, former habit and favourable change on habit as well as less perceived barriers between baseline and follow-up periods. For vegetables, lower baseline intake, former negative attitudes towards vegetables, liking vegetables at baseline and a higher change on knowledge emerged as the strongest determinants of vegetable intake. Two preference patterns emerged in our study: “High fruit and vegetable preferences” and “High fruit and low vegetables preferences”.

Participants perceived the Pro Greens to be a valuable intervention program. They recognized that the intervention had a positive influence on their fruit and vegetable consumption both at home and at school. A broad range of activities to include in future programs emerged from the adolescents' discussions. Taste sessions, competitions that combined physical activity with healthy eating, theatre plays, use of celebrities, price campaigns and FV schemes were the most frequently mentioned. The present research findings constitute an important basis to plan, design and implement effective policies aiming to promote fruit and vegetable consumption in children.
Resumo

O consumo adequado de fruta e hortícolas pode contribuir para a prevenção de inúmeras doenças crónicas. Contudo, a maioria das crianças nos países ocidentais, incluindo Portugal, não atinge as recomendações alimentares.

Um local ideal para promover o seu consumo junto das crianças, de forma alargada, é a escola. Por conseguinte, um número considerável de programas têm sido desenvolvidos para serem implementados nas escolas, procurando abranger os determinantes de consumo de fruta e hortícolas. No entanto, boa parte da literatura tem-se centrado em intervenções muito complexas, cujo desenvolvimento muitas vezes não teve em consideração as características socioeconómicas, geográficas e culturais das diferentes populações.

A presente tese integra-se no projeto europeu Pro Greens e tem como objetivo avaliar os efeitos da intervenção Pro Greens em crianças portuguesas, nomeadamente através da avaliação das diferenças no consumo de fruta e hortícolas e nos seus determinantes. Finalmente, as opiniões dos participantes foram apresentadas e discutidas recorrendo a metodologias qualitativas.

Foi utilizada uma amostra de conveniência com crianças dos 11 aos 13 anos de idade, provenientes de 5 escolas do Ensino Público no Norte de Portugal. 2 das escolas foram aleatoriamente selecionadas para a intervenção. Os determinantes e os elementos da intervenção foram cuidadosamente selecionados e organizados em três componentes principais: sala de aula, escola e família.

As crianças das escolas controlo e intervenção completaram um questionário de administração direta para avaliar o consumo de fruta e hortícolas e os seus determinantes em maio de 2009 e, novamente, em maio de 2010, após a intervenção ter sido concluída. 690 crianças completaram ambos os questionários.

Mais tarde, conduziram-se grupos focais com antigos participantes da intervenção Pro Greens para examinar as suas percepções sobre o programa e sugestões para o desenvolvimento de intervenções futuras.
O consumo de fruta e hortícolas aumentou significativamente no grupo de intervenção quando comparado com o grupo controlo.

O conhecimento sobre as recomendações para o consumo de fruta e hortícolas, levar fruta / hortícolas para a escola e a disponibilidade em casa, foram os determinantes que revelaram uma evolução mais pronunciada e significativa no grupo de intervenção.

Os melhores preditores de evolução do consumo de fruta, em ambos os grupos foram o baixo nível de ingestão no início, o hábito de consumir fruta no início e no final da intervenção bem como a menor percepção de barreiras ao consumo entre o início e o fim.

Para os hortícolas, o baixo nível de ingestão e atitudes negativas em relação aos hortícolas no período pré-intervenção e uma maior evolução no conhecimento entre a fase pré e pós intervenção revelaram ser os melhores preditores de evolução no seu consumo.

Do nosso estudo emergiram dois padrões de preferências: “Preferência elevada por fruta e hortícolas” e “Elevada preferência por fruta e baixa por hortícolas”.

Os participantes entenderam que a intervenção teve benefícios e afirmaram que esta os fez consumir mais fruta e hortícolas quer na escola quer em casa.

Sugeriram uma gama alargada de atividades para incluir em futuros programas. Provas de sabores, atividades competitivas que aliem a atividade física à alimentação saudável, peças de teatro, recurso a figuras públicas / famosas, campanhas de redução de preço e regimes de fruta e hortícolas foram as atividades mais frequentemente mencionadas.

Os resultados desta tese constituem uma base sólida para o planeamento, desenho e implementação de políticas efetivas de promoção do consumo de fruta e hortícolas em crianças.
General

Introduction
1. Introduction

1.1. Fruit and vegetables: health benefits, recommendations and consumption

The importance of adequate fruit and vegetable intake as an essential part of a healthy lifestyle has received an increasing amount of attention during the last decades. It is well known that an adequate intake of fruit and vegetables promotes health as it is important in the prevention of non-communicable diseases such as hypertension, cardiovascular disease, stroke, obesity and certain types of cancer, which nowadays constitute public health problems (Boeing et al., 2012; Carter et al., 2010; Hartley et al., 2013; Joshipura et al., 1999; Maynard et al., 2003; Van Duyn and Pivonka, 2000).

Projections suggest that in 2020, 3.4 million Europeans will develop cancer with 2.1 million deaths as a result of the disease. However, an estimated 80% of heart disease, stroke and diabetes type II, and 40% of cancer could be avoided if major risk factors were eliminated, which among them, low intake of fruits and vegetables play an important part (EPHAC, 2010).

The molecular mechanisms that explain the health protection provided by fruit and vegetables are not yet fully understood. It is known that they are good sources of several minerals and vitamins, antioxidants, fibre and other bioactive compounds, and possibly this preventive potential is associated with the additive and synergistic effects of phytochemicals present in fruit and vegetables (Liu, 2004).

Phytochemicals are defined as bioactive nonnutrient plant compounds present in fruit, vegetables, grains, and other plant foods and have multiple mechanisms of action, including, among others, antibacterial and antiviral activities, inactivation of reactive oxygen species, stimulation of the immune system, modulation of detoxification enzymes and hormone metabolism (Heber, 2004; Liu, 2003).

Given the amount of evidence suggesting a potential benefit for global health, recommendations for the consumption of fruits and vegetables have been issued by most national and international health agencies.

However, most of the national dietary guidelines only give vague qualitative advice, but some of them (namely the Portuguese one) provide quantitative information in
portions or servings (Agudo, 2005). Although there isn’t a consensual definition of portion, the average value of 80 grams can be considered adequate and allows a standardized measurement of fruit and vegetable intake across countries. This value derives from some common definitions used in most countries: a portion of vegetables, often described as a volume of 250 ml of raw leafy vegetables or 125 ml of cooked or chopped vegetables is approximately 80 grams; for fruit portions, the edible part of one whole medium-sized fruits accounts for at least 80 grams (Agudo, 2005). Similarly, the ’5-a-day’ message, adopted by most international and national health promotion agencies, producers and retailers (Stables et al., 2002) also refers to the 80 grams portion /day.

Although there is some debate about the inclusion/exclusion of potatoes, fruit juice, vegetable soup and tubers (Yngve et al., 2005), most recommendations for fruit and vegetable consumption are quite identical, namely the ones from the United Nations Food and Agriculture Organization and from the World Health Organization Expert Consultation on Diet, Nutrition, and the Prevention of Chronic Diseases, supporting an intake of at least 400 grams of fruits and vegetables per day (excluding starchy tubers such as potatoes) for the prevention of chronic diseases (WHO, 2003).

When considering fruit and vegetable consumption between and within the European countries, large differences are found (Agudo et al., 2002; Roos et al., 2001; Yngve et al., 2005). Studies show that a large proportion of the European population, including children and adolescents, has a low consumption of fruit and vegetables compared to the WHO recommendations (Fischer et al., 2011; Lien et al., 2001; te Velde et al., 2006; Yngve et al., 2005).

According to food balance sheets from the Food and Agriculture Organization (Hill, 1997) and some dietary studies (Roos et al., 2001; Trichopoulou et al., 2002) there seems to be a “North-South gradient” in fruit and vegetable consumption among countries, with the highest intakes in the south and lower intakes in the north and east. However, this gradient is gradually fading away as southern countries are rapidly changing towards a lower consumption pattern, while the reverse, an increase in fruit and vegetable intake in northern countries has been observed (Hill, 1997).

Portugal has gradually moved away from a Mediterranean diet to a more Westernized one (Cruz, 2000; Rodrigues and de Almeida, 2001). From 1987 to 1999, results from
the National Health Surveys showed a decline on the intake of traditional foods such as fish and soup whereas the consumption of others, for example, meat and milk increased steeply (Marques-Vidal et al., 2006).

According to the latest Health Behaviour in School-aged Children (HBSC) survey 2009/2010 (Currie, 2012) only around half of the European girls and one-third of boys aged 11 years-old ate at least one piece of fruit daily. Overall, boys in Denmark (51%), Belgium (49%) and Switzerland (46%), and girls in Denmark (60%), Portugal (57%) and Slovenia (57%) had the highest rates of daily fruit consumption. In all countries, there was a considerable gap between girls and boys, with girls showing a higher consumption in around three quarters of countries and regions. Daily vegetable consumption was reported, on average, by 40% of 11-year-old girls and around one-third of boys across European countries in 2009-10 and it was more common among Belgian and Ukrainian girls and Belgian and French boys. Only about one third of Portuguese children reported eating vegetables at least every day or more than once a day but again, girls showed to have a higher consumption than boys. Moreover, fruit and vegetable consumption in Portuguese children aged 15-years-old was considerably lower than in 11-year-olds. In line with these results, the Pro Children cross-sectional survey has shown that fruit and vegetable consumption among Portuguese children was high in the European setting, but still low compared with the recommendations of at least 400 g/d: the proportion of compliers with WHO recommendations was only 21% (Yngve et al., 2005). Furthermore, it is consensual that the transition from childhood to adolescence often implies undesired changes in eating behaviours (Lytle et al., 2000; Siega-Riz et al., 1998), including lower fruit and vegetable intake.

European policy-makers began to pay attention to the promotion of fruit and vegetables among children and adolescents. The European Commission has announced funding for school fruit and vegetable schemes across Europe (de Sa and Lock, 2008). As a result, the School Fruit Scheme (SFS) was launched in Portugal in 2009, providing two pieces of fruit or vegetables per week (during 30 weeks per school year) to primary school students and enrolling them in activities related to healthy eating habits in the school setting (MADR /MPS /ME, 2009). However, the SFS is not mandatory in Portugal. A recent report carried with 3798 students which assessed the impact of this program in Portugal, showed that the consumption of fruit reported by
students in schools with and without SFS did not presented significant statistical difference, although students attending the SFS schools consumed fruit in mid-morning and mid-afternoon in greater proportion than students attending schools without SFS (General Health Directorate, 2012).

1.2. Measuring fruit and vegetable intake

A broad range of methods to measure fruit and vegetable intake has been developed throughout the years. All methods show some limitations, but they are extremely relevant for research that seeks to determine fruit and vegetable intake patterns, optimal levels of intake for health, trends in food consumption, as well as for evaluation purposes as in case of interventions designed to increase fruit and vegetable consumption (Agudo, 2005; Bensley et al., 2003).

One major limitation in the assessment of fruit and vegetable intake is that the collective term “fruit and vegetables” covers a very heterogeneous group of foods that differ among countries and food cultures. Even in a “typical” Western diet, this group includes a wide variety of roots, leaves, stems, fruit, and seeds whose use varies over time and place (Lampe, 1999).

Additionally, there is variability in the definition of fruits and vegetables by individuals – despite the precision of the botanical definition, the culinary use tends to override the scientific concept. This is certainly the case of tomato and cucumber, as the common people consider them vegetables but they are indeed fruits (Roark and Niederhauser, 2013).

Food balance sheets provide estimates of food availability at national level and constitute a useful tool for international comparisons and time trend analysis. Their main limitation is that they reflect national food availability rather than actual food intake (Sasaki and Kesteloot, 1992).

Other possible approach for fruit and vegetable measurement is the household budget survey, that quantifies food and beverage availability in representative samples of households, although it doesn’t provide information about its individual members (Trichopoulou et al., 2003).

At the individual level, methods to collect information are mainly based on records or recalls as food diaries, weighed records, 24-hour recalls, food frequency
questionnaires and diet histories (Baranowski et al., 1997; Bensley et al., 2003; Cullen et al., 1999; Eldridge et al., 1998; Kim and Holowaty, 2003). As most of them rely on memory, some problems with the recall may occur. The quality and validity of dietary data collected at the individual level depends directly on respondents’ ability and willingness to provide accurate information on their intakes (Johansson et al., 2001). The combination of different methods may reduce measurement errors and thus improve intake estimation.

In the particular case of fruit and vegetable measurement, the most commonly used instruments are the 24-hour dietary recall and the food frequency questionnaire. Despite the limitations associated to the use of memory, both have good compliance (Roark and Niederhauser, 2013). The 24-hour dietary recall is often considered the most accurate method for obtaining fruit and vegetable intake data (Greene et al., 2008; Subar et al., 2007) – and it is more appropriate to measure group mean intake (assuming population representativeness and that they are well distributed among seasons and weekdays), while the food frequency questionnaire fits better to rank subjects by level of intake rather than to produce information regarding actual intake (Kim and Holowaty, 2003).

A more objective indicator of fruit and vegetable intake is the assessment of blood biomarkers, namely vitamin C and carotenoids (Woodside et al., 2013).

1.3. Fruit and vegetables: main determinants of consumption and the importance of targeting interventions to children

Several theoretical models have been used to predict intake of fruit and vegetables in children and adolescents, of which the Theory of Planned Behaviour, the Attitude – Social Influence – self-Efficacy model, and Social Cognitive Model are well known and frequently used (Baranowski et al., 2003; Bogers et al., 2004; Brug et al., 1995; Rasmussen et al., 2006). However, Rasmussen and colleagues (2006) concluded that the majority of studies carried out on potential determinants of fruit and vegetable intake lacked a clear theoretical basis.

According to several reviews the most important determinants of fruit and vegetable consumption among young people are availability and accessibility at home, preferences, liking, parental intake and parental modelling (Blanchette and Brug, 2005;
Geller and Dzwaltowski, 2009; McClain et al., 2009; Pearson et al., 2009; Rasmussen et al., 2006; van der Horst et al., 2007). In fact, parents play a direct role in children’s and adolescents’ eating patterns and consequently it is advocated that interventions targeting children and adolescents also need to address the family (Cullen et al., 2003; Patrick and Nicklas, 2005; Rasmussen et al., 2006).

The most effective interventions have been shown to be comprehensive multi-component ones, targeting several determinants. Four bibliographic reviews (Delgado-Noguera et al., 2011; Evans et al., 2012; Knai et al., 2006; Van Cauwenberghe et al., 2010) allowed the identification of important factors for a successful intervention:
- **duration** of at least 6 months;
- **total involvement** of the whole school community and canteen staff;
- **teachers’ training** and **integration in the school curriculum**;
- **encouragement** and **peer leadership**;
- **inclusion of parents**, both at home and at school.

As food patterns are established early in life (Kelder et al., 1994; Lien et al., 2001), a number of studies showed that fruit and vegetable consumption patterns and preferences in childhood are predictive of patterns in adolescence and adulthood (Kelder et al., 1994; Kvaavik et al., 2005; Lien et al., 2001; Lytle and Kubik, 2003). Moreover, children are more receptive to changes in their dietary pattern than adults (Lien et al., 2001), for whom some dietary habits namely low consumption of fruit and vegetables have often become usual (Krebs-Smith et al., 1995).

1.4. Qualitative approaches to explore children’s perceptions, determinants and experiences with fruit and vegetables: Focus Group interviews

Although quantitative studies are fundamental to identify, quantify and rank the importance of different determinants for children’s and adolescents’ fruit and vegetable consumption and to assess their socio-demographic variations, qualitative research can add to this knowledge in several ways. It provides the opportunity to identify unknown factors as the research techniques give room for unprecedented answers as opposed to the highly structured interviews used in surveys, and also allow to explore new topics and directions thereby using the respondents' own words to give meaning to their world (Krolner et al., 2011).
Krueger (1994) describes focus groups as “a carefully planned discussion designed to obtain perceptions on a defined area of interest in a permissive, nonthreatening environment”. Focus group discussions allow the researcher to probe both cognitive and emotional responses of participants while observing the underlying group dynamic. Evidence suggests that focus groups are a valuable mean of eliciting children’s views on health-related matters, given an appropriate research question (Heary and Hennessy, 2002; Peterson-Sweeney, 2005).

One of the great advantages of focus groups is their flexibility – they combine well with other qualitative and quantitative methods (Morgan, 1997). As a drawback, focus groups aren’t proper to draw inferences for larger populations or for statistical testing (Heary and Hennessy, 2002) and its results are also subject to social desirability bias, which may be specially pronounced in children.

To conduct successful focus groups with children and adolescents, it is important to be aware of methodological issues. First of all, children’s and adolescents’ developmental abilities and needs should be known; secondly, the interview has to be designed in order to elicit interest and, at the same time, to be understandable by them. It is also important to realize that the size of the group and the length of the interview are determinant factors for the success of the interview: some authors recommend groups with four to six participants (Hoppe et al., 1995) and a maximum duration of 60 minutes for the discussion (Vaughn et al., 1996).

This methodology seems to be an excellent approach when conducting research in paediatric and adolescent health care to include the perspective of youth when designing health intervention programs (Peterson-Sweeney, 2005). When designing interventions for fruit and vegetable promotion, it is important to involve participants from the early stages in order to gain insight on the potential determinants of consumption as well as on the activities that should be enrolled during the intervention in order to make it more effective and attractive. Qualitative research can add by bringing new knowledge about behaviour determinants and describe the cultural patterns associated with particular settings (Cho and Nadow, 2004; Draper, 2004). It is somewhat common to conduct focus group interviews as part of the stepwise development of an intervention program. There is a broad range of qualitative studies conducted to inform the components of an intervention program.
(Berge et al., 2012; Boddy et al., 2012; Kubik et al., 2005; Williams et al., 2011; Wind et al., 2005; Zeinstra et al., 2007). However, it is not so common to assess participants’ opinions and views on these programs at the end of the intervention, with quantitative evaluation methods being commonly regarded as the “gold standard” to assess the outcomes of a program. Qualitative research doesn’t provide results that can be generalized and the sample used cannot be a random sample. Furthermore, it is only adequate for outcome evaluation of an intervention; it wouldn’t be appropriate to conduct qualitative research for impact assessment. However, it is useful to conduct qualitative research to evaluate an intervention program since it can provide information, directly brought by participants, on why intervention may or may not have worked. Furthermore, it also allows deepening and probing findings brought by quantitative research.

1.5. Outline of this thesis

The present thesis is based on the Pro Greens study in Portugal. Following this introduction, the research aims are presented in chapter two. Chapter three focuses on the methodology, describing the project, the strategies implemented in the intervention in Portugal as well as the questionnaire used to assess fruit and vegetable intake and its determinants among children.

The data analysis is presented in four scientific papers – chapter four – of which the candidate is the main author.

In the final chapter – chapter five – the main findings of this thesis are summarized, methodological issues are addressed and implications for public health and directions for further research are highlighted.
1.6. References


Research Aims
2. Research aims

The overall aim of the current thesis was to study the determinants of fruit and vegetable intake among schoolchildren and to evaluate the Pro Greens intervention in Portugal.

The specific aims were to:

- evaluate the effects of the Pro Greens intervention on fruit and vegetable consumption among Portuguese schoolchildren (Paper I);
- assess the effects of the Pro Greens intervention on personal, social and physical environmental determinants of fruit and vegetable consumption (Paper I) and the way these determinants alter across one school year in intervention and control schools (Paper II);
- identify fruit and vegetable preference patterns among Portuguese schoolchildren and analyze their association with fruit and vegetable consumption and with the determinants of fruit and vegetable consumption (Paper III);
- gain insight into the views and opinions of former participants of the Pro Greens intervention, three years after the intervention has been completed (Paper IV);
- qualitatively identify the factors related to fruit and vegetable consumption on former participants of the Pro Greens intervention (Paper IV);
- elicit former participants’ opinions on the activities that they consider relevant to be included in intervention programs to promote fruit and vegetable intake in order to inform the design of future interventions (Paper IV).
Methodology
3. Methodology

3.1. The Pro Greens project

The Pro Greens, “Promotion of vegetable and fruit consumption in schoolchildren” was a health promotion project funded by the Health and Consumer Protection Directorate General of the European Commission, carried out in ten European countries. Pro Greens built on a previous project – Pro Children (2003-2006) – conducted in nine European countries that aimed to assess fruit and vegetable consumption and determinants of consumption in European schoolchildren. It also aimed to design, implement and evaluate an intervention program (Klepp et al., 2005).

Pro Greens took five former Pro Children countries (Iceland, the Netherlands, Norway, Portugal and Sweden) and included five new partners (Bulgaria, Finland, Germany, Greece and Slovenia).

A unique feature of Pro Greens was that each "new" country worked together with a former participant country.

Between 2008 and 2011, the results and developments of Pro Children project were further developed and implemented by the Pro Greens partners. The focus of the project was the intervention, that is, to assess the level of consumption of fruit and vegetables in children before and after a school-based intervention. The study was divided in three phases: baseline survey (May 2009), intervention (November 2009-May 2010) and follow-up (May 2010). The activities took place in the participating countries at the same time and used the same materials.

The project aimed to identify effective strategies for fruit and vegetable promotion, with sustainable and more affordable methods, using the available resources and public private partnerships.

A minimum of 1000 11-year-old schoolchildren were recruited in each country. In most cases (including Portugal), a convenience sample was used.

The intervention took place in all countries (except the Netherlands) and it was developed based on the Pro Children rationale (Klepp et al., 2005; Perez Rodrigo et al., 2004; Te Velde et al., 2008) as well as on the Intervention Mapping protocol (see figure 2, (Bartholomew et al., 2006). Partners were free to select the strategies to include in
the intervention period. The only common requirement was that the chosen intervention strategies should all target the core determinants of fruit and vegetable consumption.

**Figure 2. The Intervention Mapping Protocol (Bartholomew et al., 2006)**

The validated Pro Children questionnaires (De Bourdeaudhuij et al., 2005; Haraldsdottir et al., 2005) for children and school staff were adapted for use in this project. In the children questionnaire some minor adjustments were made related to the questions on the lunch meal; the school staff questionnaire was partly changed and new questions on school policy were added from the Norwegian “HEalth In Adolescents” (HEIA) study (Lien et al., 2010) questionnaire. Parental questionnaires
only included some socio-demographic questions that the children would not be able to answer. These instruments were originally developed in English and then translated into the relevant language within each participating country and back translated to English.

Children data collection was performed in the classroom with supervision from teachers that received detailed instructions prior to the investigation. One school lesson (approximately 45 minutes) was used to complete the baseline and the follow-up questionnaire. At the first data collection, children also received a closed envelope with a questionnaire to take home to be completed by one of the parents / guardians. These questionnaires were then returned to the teachers in a sealed envelope, and collected from the schools by project staff.

A data management handbook was produced by the data management centre, built on the Pro Children data management handbook, and each national centre followed the standardized protocols. Further quality control was carried out at the Data Management Centre in Iceland.

This project was carried out in accordance with the universal ethical principles (Emanuel et al., 2000). Research permission was obtained from national and local schools authorities, as well as from the school administration before parents and students were contacted.

Parents were reached by mail or through the class teacher in order to provide written informed consent for their child and for themselves.

3.2. Pro Greens project in Portugal: survey and description of the intervention

The research design followed the scheme as in Figure 3. Briefly, a convenience sample was performed and 5 Primary schools from the public education system were contacted and invited to participate. These schools were located nearby the research centre, in the North region of Portugal. All the schools accepted to participate and had 1004 children, aged between 11-13 years-old, eligible to participate in the project, distributed by 41 classes. Schools were then randomly assigned into the intervention (2 schools) or control arms of the study (3 schools). From the 1004 eligible students, 898 participated and have correctly completed the questionnaire at baseline (89.4%
response rate) and 744 students completed the follow-up questionnaire (74.1% response rate).

**Figure 3. Research design**

<table>
<thead>
<tr>
<th>Recruitment of schools</th>
<th>Random assignment</th>
<th>Baseline data collection</th>
<th>Intervention</th>
<th>Follow-up data collection</th>
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Between November 2009 and May 2010, a multi-component intervention was implemented in the two intervention schools, in agreement with the requirements of the project for all the partners and having in account the elements that have been identified as successful key elements of a school-based intervention, namely: interventions should focus on specific eating behaviours; should be guided by behavioural theory; devote adequate time and intensity; involve families and preferably include changes in the school environment; and possibly include the use of multimedia or web-based tools (Blanchette and Brug, 2005; Knai et al., 2006).

**Pro Greens intervention in Portugal consisted of three main components:**

(a) A classroom component, namely school based educational material for children consisting of a set of worksheets with guided activities for the classroom and to complete as homework, to develop knowledge, increase awareness and skills of children regarding fruit and vegetables. These worksheets had a particular emphasis on the taste sessions carried out by nutritionists that aimed to encourage children to use their senses to become familiar with a wide variety of fruits and vegetables. Additionally, a teachers’ manual with instructions to conduct the sessions was provided. Further, it was explicitly asked to the children to bring fruit and / or vegetables from home on schooldays; a special fruit and vegetable break was implemented in at least one school day per week.

(b) A school component that included educational sessions with children and teachers, delivered by Nutritionists from the research team, and the development of a blog entitled *City of Greens* to reinforce the knowledge on fruit and vegetables through
some playful didactic activities. Additionally, this component also included visits to local markets and supermarkets to promote contact with different fruits and vegetables. There was also a punctual provision (for three times) of fruit and vegetables for free at school.

(c) A family component, consisting of active parent involvement in children’s homework assignments. Parents were informed about these tasks by letters from the researchers. Newsletters for parents were developed that included a variety of information on fruit and vegetable, announcements about ongoing activities in the Pro Greens intervention and educational sessions, delivered by Nutritionists, to give tips to encourage their children to eat more fruit and vegetables.

3.3. Instrument

A comprehensive survey instrument assessing fruit and vegetable consumption and psychosocial factors associated with these consumption patterns was adapted, as aforementioned, from the Pro Children questionnaire. The questionnaire was brief, easy to read and self-explanatory, keeping in mind the young age of the children. It comprised three major parts:

- a dietary part (a 24-hour recall assessment and food frequency items and were included in the instrument in order to assess fruit and vegetable intake at an individual level as well as at a group level);
- a determinant part to study personal, social and physical environmental factors of daily fruit and vegetable intake;
- a third part asking about screen time during weekdays and weekends and exercise outside the school hours.

Parents’ questionnaire provided information on household size and composition, education level and region of residence. Educational level was measured by four categories: less than 7 years; 7-9 years; 10-12 years and more than 12 years of school attendance.

These questionnaires can be accessed at: www.progreens.org
3.3.1. *Fruit and vegetable consumption*

The dietary part of the questionnaire, as previously mentioned, comprised two sections: a precoded 24-hour recall and food frequency items. In the 24-hour recall section participants were asked to describe in detail the amounts in terms of pieces, slices or portions of fresh fruit, fruit juice, salad, other raw vegetables, cooked vegetables and vegetable soup they had eaten the day before in three different time intervals: (1) before school; (2) school time and lunch; (3) after school, dinner and after dinner. Total vegetable intake was calculated by summarizing all answers about vegetables. Standard weights were attributed to each one of the food items in order to quantify intake (see Table 1 (Haraldsdottir et al., 2005)).

The food frequency section included with five distinct questions: “How often do you usually eat: fresh fruits / salads or grated vegetables/ other raw vegetables/ cooked vegetables (including vegetable soup) / 100% fruit juice?” Each one of these questions had eight response alternatives, ranging from “never” to “every day, more than twice a day”. To avoid misunderstanding, an additional question about potatoes was included. Mean total frequency of vegetable intake and combined fruit and vegetable intake were calculated by summarizing the respective answers. The food frequency questions proved to be fairly accurate in ranking children’s fruit and vegetable intake (Haraldsdottir et al., 2005).
Table 1. Definition of portion sizes for the questionnaire used in the European Pro Greens study (adapted from the Pro Children Questionnaire) (Haraldsdottir et al., 2005)

<table>
<thead>
<tr>
<th>Food item in the 24-hour recall</th>
<th>Portion size (g/ portion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit</td>
<td></td>
</tr>
<tr>
<td>Apple, banana, orange, pear (pieces)</td>
<td>100</td>
</tr>
<tr>
<td>Tangerine (piece), melon (slice)</td>
<td>50</td>
</tr>
<tr>
<td>Fruit salad (portion)</td>
<td>100</td>
</tr>
<tr>
<td>Other fruits (pieces, portions)</td>
<td>100</td>
</tr>
<tr>
<td>Fruit juice</td>
<td>200</td>
</tr>
<tr>
<td>Raw vegetables</td>
<td></td>
</tr>
<tr>
<td>Tomato (piece)</td>
<td>50</td>
</tr>
<tr>
<td>Cucumber (slice)</td>
<td>10</td>
</tr>
<tr>
<td>Carrot (piece)</td>
<td>65</td>
</tr>
<tr>
<td>Other raw vegetables (portions)</td>
<td>50</td>
</tr>
<tr>
<td>Salad</td>
<td>40</td>
</tr>
<tr>
<td>Cooked vegetables</td>
<td>60</td>
</tr>
<tr>
<td>Vegetable soup</td>
<td>80 (per each 250 g of soup)</td>
</tr>
</tbody>
</table>

3.3.2. Determinants of fruit and vegetable consumption

Derived from the Pro Children project, the final Pro Greens model distinguished four levels of determinants. First the most distal demographic determinants, second the physical environmental determinants, third the social environmental determinants and fourth the most proximal personal determinants of fruit and vegetable consumption (Klepp et al., 2005).

Potential correlates of fruit and vegetable intake were measured within the domain of:

**Demographic factors** (country, gender, age and family status);

**Personal factors** (knowledge about recommended daily intake levels, attitude towards eating of fruit and vegetables, general self-efficacy to eat fruit and vegetables, liking fruit and vegetables, preferences for fruit and vegetables, and perceived barriers to prevent eating fruit and vegetables);

**Social-environmental factors** (modelling behaviour of friends and parents, active parental encouragement, parental facilitation, parental demand and parental allowance);
Physical-environmental factors (perceived availability of fruit and vegetables at home and perceived availability of fruit and vegetables in other settings i.e. at school, at their friends’ home and at the sports club).

All factors, except knowledge, were assessed using a five-point scale that ranged from “fully disagree / never / dislike very much” (-2) to “fully agree / yes / like very much” (+2). To assess knowledge of recommended daily intake levels, children were asked on an eight-point scale how much fruit or vegetables they should eat every day. Response options ranged from “no fruit or vegetables” (0) to “five pieces or portions per day or more” (7).

3.3.3. Screen time and exercise

TV viewing and the use of the computer were assessed with two questions: ‘About how many hours a day do you usually watch television and videos / spend in front of the computer (emailing, surfing, chatting, playing games) and / or playing video games in your leisure time on weekdays / on weekends?’ These questions had 9 response options ranging from ‘none at all’ to ‘about 7 hours a day or more’.

Question on physical activity was based on recommended levels of physical activity for this age group. The variable used asked: ‘Outside school hours, how many hours a week do you usually exercise in your leisure time so much that you get out of breath or sweat?’ and response options were: 'None', 'about half an hour', 'about 1 hour', 'about 2-3 hours', 'about 4-6 hours' or '7 hours or more'.

3.4. Qualitative research

A qualitative approach was used to gain more insight and understanding about student’s views on the Pro Greens intervention as well as on the possible outcomes and factors related to their fruit and vegetable intake.

As suggested by Morgan and Krueger (1998) an interview guide to facilitate the focus groups was developed (see Table 2).
Table 2. General questioning route for the focus group interviews

**Introduction and icebreaker question**
We would like to thank you for being here today. The purpose of this meeting is to better understand your views and feelings about fruit and vegetables and on a program that was implemented at your school some time ago, in which you were enrolled – The Pro Greens. Firstly, we would like to ask the first thing that comes to your mind when you think of fruit and vegetables. Of which do you remember first? What smells, tastes, colours and sensations occurs to you when you think about them?

**A. Factors related to FV consumption and choice**
- Usually where do you eat fruit / vegetables (at home, at school ...)? In which meals and with who do you eat fruit / vegetables?
- Is it usual to have a lot of variety of fruit / vegetables at home? Do your parents or other relatives ask you to eat fruit / vegetables?
- What do your parents say about fruit / vegetables?
- Is there anyone that you consider to influence your fruit / vegetables intake?
- Can you explain what the recommendations for fruit and vegetable intake mean? Does anyone know how many portions / pieces of fruit and vegetables we should eat daily?
- Do you think you eat adequate amounts of fruit and vegetables?
- Who eats fruit / vegetables daily?
- Who eats fruit / vegetables never or hardly ever? Why?

**B. Program Evaluation and Inputs for future**
- Do you remember Pro Greens program?
- What is your overall impression of the program? Did you enjoy participating in the Pro Greens?
- Did you talk about Pro Greens with your family or friends?
- Imagine you were going to tell a friend that doesn’t attend your school about the Pro Greens. What would you tell about the program?
- Regarding the program, what are the things you like? What are the things you dislike?
- Do you feel that the program changed the amount of fruit and vegetables that you consume now? (free elicitation)
- What kind of activities do you think that should be included in future programs with identical purposes of the Pro Greens?
- What could we do to help you eat more fruit and vegetables?

Development of the interview guide was based on findings from literature reviews (Krolner et al., 2011) and original qualitative studies (He et al., 2012; Monge-Rojas et al., 2005; Neumark-Sztainer et al., 1999; Wind et al., 2005) investigating determinants/motivators and barriers for healthful eating, particularly for fruit and vegetable consumption and evaluating an intervention program.

Ethical approval was granted by the University of Porto Ethics Committee. Written informed consent was obtained from the parents/guardians of all students that participated. In addition, students participated on a voluntary basis.

All the sessions were held at school during school hours. The focus group interviews were conducted by a facilitator/moderator and a research assistant who took field notes about the interaction, including physical gestures and details about the
surroundings throughout discussion and monitored the interview process. Each interview lasted between 30 minutes to 50 minutes and was audio-taped. 6 focus groups were conducted involving students aged 14-16 years old, who were divided into 4-6 participants per group. After verbatim transcription of the interviews, significant patterns in focus group responses were grouped according to common themes using the cut and paste technique (Stewart and Shamdasini, 2007). With this method, the first author identified a coding system for major issues and themes, using different symbols to identify distinct topics within each transcription. The coded transcripts were then cut apart and pasted in order to gather all the information on an identified topic. Topics prioritization was based on the frequency and extent to which topic was discussed during the focus group session. A second researcher independently reviewed analyzes for final data interpretation. At the end of the process, a final summary report was prepared and reviewed by the whole research team.
3.5. References


Effects of a school-based intervention to promote fruit and vegetable consumption: the Pro Greens Project in Portugal

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[Submitted for publication]

Abstract

Objective: The purpose of this study was to assess the effects of a school-based intervention on fruit and vegetable consumption and on personal, social and physical environmental variables regarding fruit and vegetable behaviours.

Design: A survey was performed in May 2009 and May 2010, before and after a school-based intervention to compare intervention with control schools.

Setting: Five schools from the North of Portugal (belonging Porto Metropolitan Area).

Subjects: 11-year-old schoolchildren; Complete questionnaires were available for 690 children and 618 questionnaires from parents / guardians.

Results: Total fruit and vegetable consumption increased significantly in the intervention group (mean = 307.4 (SE 12.1) g/d) compared with the control group (mean = 266.3 (SE 10.6) g/d; P = 0.011).

The determinants of fruit intake with a higher and significant evolution in the intervention group were knowledge about recommended levels, liking, preferences, perceived barriers, parental facilitation and demand, to bring fruit to school and perceived availability at home. For vegetables, knowledge, active parental encouragement, to bring vegetables to school and perceived availability at home revealed a significant higher evolution in the intervention group.

Conclusion: Although the amount of increase was small, the school-based intervention was effective in increasing fruit and vegetable intake. Our results provide information
for public health policy makers and practitioners, particularly in Portugal, regarding strategies to facilitate efficacious implementation and evaluation of health promotion programs on fruit and vegetable consumption.

**Keywords:** Fruit; Vegetables; Schools; Children; Intervention

**Efeitos de uma intervenção em escola para a promoção do consumo de fruta e hortícolas: o Projeto Pro Greens em Portugal**

**Resumo**

**Objetivo:** O objetivo deste estudo foi avaliar os efeitos de uma intervenção em escola nos padrões de consumo de fruta e hortícolas e nos fatores pessoais, sociais e físico-ambientais relacionados com os comportamentos de consumo de fruta e hortícolas.

**Desenho:** Foi aplicado um inquérito em maio de 2009 e em maio de 2010, antes e após uma intervenção em escola, para comparar as escolas intervenção com as escolas controlo.

**Local:** 5 escolas do Norte de Portugal (pertencentes à área Metropolitana do Porto).

**Participantes:** Crianças com 11 anos de idade. Obtiveram-se questionários corretamente preenchidos de 690 crianças e 618 pais.

**Resultados:** O consumo de fruta e hortícolas aumentou significativamente no grupo de intervenção (média = 307,4 (erro-padrão 12,1) g/d) comparativamente com o grupo controlo (média = 266,3 (erro-padrão 10,6) g/d; \( P = 0,011 \)).

Os determinantes de ingestão de fruta com uma evolução mais significativa foram o conhecimento sobre os níveis de ingestão recomendados, gostar, preferências, barreiras percecionadas, facilitação e exigência parentais, levar fruta para a escola e disponibilidade em casa. Nos hortícolas, o conhecimento, o encorajamento parental, levar hortícolas para a escola e a disponibilidade em casa revelaram uma evolução significativamente superior no grupo de intervenção.

**Conclusão:** Embora o aumento tenha sido pequeno, a intervenção em escola foi efetiva no aumento da ingestão de fruta e hortícolas. Os nossos resultados fornecem informação para os decisores e profissionais de saúde pública, particularly em
Portugal, no que diz respeito às estratégias para facilitar a implementação eficaz e a avaliação de programas de saúde para a promoção do consumo de fruta e hortícolas.

**Palavras-chave:** Fruta; Hortícolas; Escolas; Crianças; Intervenção

**Introduction**

In most Western countries, overweight, cancer and cardiovascular diseases largely contribute to morbidity and mortality rates\(^1\, ^2\).

Lifestyle factors, including nutrition behaviour, play an important role in the development of these diseases. In the particular case of fruits and vegetables, there is convincing evidence that an increased consumption of such foods reduces the risk of hypertension, coronary heart disease and stroke\(^3\, ^4\) and there is probable evidence for an inverse association with the risk for cancer\(^3\, ^5\, ^6\). Likewise, there is possible evidence that an increased consumption of fruit and vegetables may prevent body weight gain and indirectly, reduce the incidence of type II diabetes mellitus\(^3\, ^7\, ^9\).

Most European countries as well as international health agencies have developed recommendations for the desirable levels of consumption of fruit and vegetables. At least 400g of fruit and vegetables per day\(^10\) or at least five portions of fruit and vegetables a day is recommended as well as reduced intakes of saturated fats and salt, and increased consumption of complex carbohydrate and fibre\(^11\). However, several surveys show that most European children and adolescents do not meet these guidelines\(^12\, ^15\).

Promoting fruit and vegetable (FV) consumption among children seems to have good potential for improving public health, as healthy food habits acquired in childhood tend to track into adulthood\(^16\, ^17\). Moreover, children’s food habits are not yet firmly established, which makes them more flexible to change\(^18\). In addition, the transition from childhood to adolescence is often associated with unhealthy dietary changes, which reinforces the importance of interventions targeting at children\(^19\).

Schools seem to represent an ideal setting to promote healthy eating and deliver programs aiming at children due to the number of weekday hours they spend there,
giving the opportunity to teach them about healthy foods and eating behaviours\textsuperscript{20, 21}. However, schools may lack resources to implement FV promoting programs and it is important that they can benefit from partnerships between health agencies, higher education institutions and other organizations able to provide funding for these programs.

Parents also constitute an important target group of these projects, as they define most of their children’s eating environment. Communication with parents can be made easier once it is known that they can be reached through their children\textsuperscript{22}. In order to achieve the potential health benefits of school-based interventions, further evidence is required regarding the strategies that are effective in facilitating the implementation of such programs at school. Although a recent review from Van Cauwenberghe et al.\textsuperscript{23} found strong evidence that multicomponent interventions with children that combine improved availability of fruit and vegetables with a nutrition education curricula and at least some parental involvement can change FV intake, the authors emphasize that more research is needed, particularly from high-quality studies with well-designed interventions.

The present paper focuses on results from the impact evaluation of the Pro Greens project in Portugal. The main aims were to assess the effect of the project on FV consumption patterns and personal, social and physical environmental variables regarding FV behaviours.

**Methods**

The present study is part of the European Pro Greens project, which is a follow-up of the Pro Children project\textsuperscript{24}. Portugal was one of the ten participating countries (\url{www.progreens.org}). Pro Greens’ main aims were to assess and provide information on FV intake before and after the intervention and to develop effective strategies to promote its consumption in 11-year-old schoolchildren across Europe.
**Design and sample**

A convenience sample was performed (close to the research centre, in Porto) with 5 elementary schools from the public education system contacted to participate. Approval to contact the schools was obtained from the Portuguese Ministry of Education.

Schools were recruited by mail and in most cases followed by a phone call and a visit to the school. Participation was voluntary. Parents were either contacted directly by mail if home addresses were available, or reached through the class teacher in order to obtain consent for the project. All 5 schools participated, with 1004 sixth graders (from 41 classes). Participant schools were allocated to the intervention and the control arms of the study.

Data were collected in two distinct periods: a baseline survey was performed in May 2009; then in May 2010, the same survey was performed in the follow-up period, by means of a self-administered questionnaire. Sixth graders (mostly born in 1998) completed their questionnaires in the classroom during school hours with teachers’ supervision. All teachers had previously received instructions from the research centre and the questionnaire also included written instructions.

As can be seen in the diagram (Fig. 1) of the 1004 eligible students, 898 participated and have correctly completed the survey at baseline (89.4% response rate) and 744 completed the questionnaire at the end of the project (17.1% dropout rate). The final matched sample of baseline and follow-up cases consisted of 690 children (310 from the intervention school and 380 from the control school), 336 girls (48.7%) and 354 boys (51.3%), with a final completion rate of 68.7%.
**Figure 1.** Diagram of the randomization and inclusion process

5 schools invited to participate
41 classes; 1004 students
1 class did not participate actively (25 students) = 979 eligible students

Cluster randomization:
Intervention (2 schools); Control (3 schools)

First data collection - Baseline survey
968 students present at first data collection day:
- 37 empty questionnaires
- 26 without parent consent
- 6 missing 24 hour recall part
- 1 gender missing
Valid data at baseline: 898 questionnaires

Intervention: 431 students  Control: 467 students

Second data collection – Follow-up survey
864 students presents at second data collection day:
- 57 empty questionnaires
- 14 undelivered questionnaires
- 5 with unreliable information
- 40 missing 24 hour recall part
- 3 gender missing; 1 age missing
Valid data at follow-up: 744 questionnaires

Available data for matched children at baseline and follow-up:
Intervention: 310 students
Control: 380 students

**Intervention**

The intervention was developed mainly on the basis of the Pro Children project\(^{24, 25}\) as well as on the Intervention Mapping protocol\(^{26}\).

Similarly to all partners of the Pro Greens project, the intervention carried in Portuguese schools consisted of three major components:

* a *classroom component* (this component included a set of guided worksheets to develop knowledge, increase awareness and skills of children regarding fruit and
vegetables. These worksheets had a particular emphasis on the taste sessions carried out by nutritionists that aimed to encourage children to use their senses to become familiar with a wide variety of fruit/vegetables. Some of the activities were carried during school hours with teachers’ supervision, while others were proposed as homework to develop with family members. Additionally, it also included at least one fruit/vegetables break per week. Teachers involved in the intervention had previous information and training on these activities;

*a school component* (it included educational sessions with children and teachers and the development of a blog entitled City of Greens to reinforce the knowledge on fruit and vegetables through some playful didactic activities and also visits to local markets and supermarkets to promote contact with different fruits and vegetables);

*a family component* (involving caregivers in children’s homework assignments. Additionally, newsletters for parents were developed, which included a variety of information on fruits and vegetables, announcements about ongoing activities in the Pro Greens and educational sessions, delivered by nutritionists, to give tips to encourage their children to eat more fruit and vegetables).

*Measures*

The primary outcome measures were the differences in children’s FV consumption in the presence or absence of the intervention, expressed in frequency (times per day) and in grams per day (24 hour recall).

The validated Pro Children questionnaire\(^{27}\) was used for the assessment of intake, after small adjustments in the lunch meal question to make it fit meal circumstances better. The English version of the questionnaire can be found at http://www.progreens.org.

The dietary part was composed of a precoded 24-hour recall part that asked in detail for the consumption of fresh fruit juice, fresh fruit, salad, other raw vegetables, cooked vegetables and vegetable soup. Amounts were indicated in terms of portions, slices or pieces eaten and standard weights were defined for these units\(^{27}\) in order to quantify intake. Total fruit and/or vegetable intake were calculated by summarizing the respective answers.

Additionally, it also included a food frequency part with five separate questions: “How often do you usually eat: fresh fruits/salads or grated vegetables/other raw
vegetables/ cooked vegetables (including vegetable soup) / 100% fruit juice?" Each of these questions had eight response alternatives, ranging from “never” to “every day, more than twice a day”. To avoid misunderstanding an additional question about potatoes was included. Mean total frequency of vegetable intake and combined fruit and vegetable intake were calculated by summarizing the respective answers. The food frequency questions proved to be fairly accurate in ranking children’s fruit and vegetable intake\textsuperscript{27}.

Fruit juices were excluded because it was proved that children of this age had problems distinguishing fruit juice from other fruit drinks or lemonades\textsuperscript{28}.

Secondary outcome measures included changes in FV correlates through the determinant part of the questionnaire. This part of the questionnaire aimed to measure several constructs that were the same for fruit and for vegetable intake, but measured separately: general self-efficacy, self-rated intake, self-rated intake compared to other children, knowledge about recommended daily intake levels, attitudes, liking, intention, habit, preferences, bring fruit / vegetables to school, perceived barriers, modelling, active parental encouragement and facilitation, family rules (demand and allowance), availability at home, at leisure (sports club), at friends’ house and at school.

All constructs, except knowledge, were assessed with a five-point scale from: ‘never / fully disagree / dislike very much’ (-2) to ‘yes / fully agree / like very much’ (+2). Preferences were assessed for 12 different fruits and vegetables. To assess the knowledge about the recommended intake, children were asked on an eight-point scale, with response options ranging from ‘no fruit or vegetables’ to ‘5 pieces or portions per day or more’. The reliability and validity of the constructs to measure correlates were assessed in a population of children from 5 of the Pro Children countries, including Portugal. The test-retest reliability was good to very good (intraclass correlation coefficient >0.60) for 12 out of the 15 fruit constructs and also for 12 out of the 15 vegetable constructs. Test-retest reliability was comparable across countries. Cronbach’s alpha values were moderate to high (range 0.52 to 0.89) with the exception of the general self-efficacy scale, which had a value below 0.50 for both fruit (α=0.42) and vegetables (α =0.49)\textsuperscript{29}. 

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In the present study, Cronbach alphas ranged from 0.55 to 0.89, which indicate better internal consistency compared to the reliability study, with the exception of the general self-efficacy scale, with values considerably below 0.5 both for fruit and for vegetables (Table 1).

Family educational level, a potential confounder, was assessed by a questionnaire completed by the parents, and was categorised based on the number of years of education completed by the parent: less than 7 years, between 7 and 9 years, between 10 and 12 years and more than 12 years. Data on parental educational level was available for 618 children (89.4 %).

Data handling and statistical analysis

A data management handbook was produced by the data management centre, built on the Pro Children data management handbook. The Portuguese research centre followed the established protocol for data entering and cleaning.

Descriptive statistics were used to describe participant characteristics, frequency of intake (in times per day) of fruit, vegetables, and combined fruit and vegetables, and intake (in grams per day) of fruit, vegetables, soup and combined fruit and vegetables / fruit and vegetables plus soup for the intervention and control groups at baseline.

Differences at baseline between both groups were explored with $X^2$ test or Student's T-test.

Since soup consumption is considerably higher in Portugal compared to other European countries\(^{15}\), data for soup consumption is presented separately from other vegetable intake.

In order to determine the evolution in the frequency of intake of fruit, vegetables and combined fruit and vegetables, net differences were calculated for each group (intervention and control) as: frequency of consumption at follow-up - frequency of consumption at baseline. The same procedure was adopted to determine the evolution of potential correlates of FV consumption.

GLM Univariate procedure was used to determine the intervention effects: outcome measures (mean intake in grams per day, frequency of intake in times per day and the evolution of the potential determinants) were the dependent variables; sex and group
(intervention or control) were the fixed factors; age, corresponding outcome measures at baseline and parental educational level were the covariates.

Since there were missing data for some of the variables, the number has slightly differed between analyses, as indicated further in the result section of this paper. Means and standard errors were reported as the differences in the outcome measures at follow-up with and without intervention, controlling for baseline values, sex, age and parental education level.

Analyses were conducted using the IBM SPSS Statistics 20.0. Missing values were excluded listwise. A p-value < 0.05 was considered to be statistically significant.
<table>
<thead>
<tr>
<th>Constructs with items</th>
<th>Response categories</th>
<th>Internal consistency Cronbach's α</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-rated intake</strong></td>
<td>5 point scale from 2 = Very many to -2 = Very few</td>
<td>Fruit: 0.691 Vegetables: 0.770</td>
</tr>
<tr>
<td>Do you think you eat much or a little fruit / many or few vegetables?</td>
<td>5 point scale from 2 = Much more to -2 = Much less</td>
<td></td>
</tr>
<tr>
<td>Do you think you eat more or less fruit / vegetables than most boys and girls of your age?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Knowledge</strong></td>
<td>8 point scale from 0 = no fruit to 8 = 5 pieces or more /day</td>
<td>N/A</td>
</tr>
<tr>
<td>How much fruit do you think you should eat to have a healthy diet?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How many vegetables do you think you should eat to have a healthy diet?</td>
<td>8 point scale from 0 = no vegetables to 8 = 5 or more portions (serving spoons) every day</td>
<td>-</td>
</tr>
<tr>
<td><strong>Attitude</strong></td>
<td>5 point scale from 2 = I fully agree to -2 = I fully disagree</td>
<td>Fruit: 0.675 Vegetables: 0.871</td>
</tr>
<tr>
<td>To eat fruit / vegetables every day makes me feel good.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To eat fruit / vegetables every day gives me more energy.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Liking</strong></td>
<td>5 point scale from 2 = I fully agree to -2 = I fully disagree</td>
<td>Fruit: 0.653 Vegetables: 0.845</td>
</tr>
<tr>
<td>I like to eat fruit / vegetables every day.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit tastes good / vegetables taste good.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>General self-efficacy</strong></td>
<td>5 point scale from -2 = I fully agree to 2 = I fully disagree</td>
<td>Fruit: 0.295 Vegetables: 0.333</td>
</tr>
<tr>
<td>It is difficult for me to eat fruit / vegetables every day.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If I decide to eat fruit / vegetables every day, I can do it.</td>
<td>5 point scale from 2 = I fully agree to -2 = I fully disagree</td>
<td></td>
</tr>
<tr>
<td><strong>Intention</strong></td>
<td>5 point scale from 2 = I fully agree to -2 = I fully disagree</td>
<td>N/A</td>
</tr>
<tr>
<td>I want to eat fruit / vegetables every day.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Habit</strong></td>
<td>5 point scale from 2 = I fully agree to -2 = I fully disagree</td>
<td>N/A</td>
</tr>
<tr>
<td>To eat fruit / vegetables every day is a habit for me.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fruit preferences</strong></td>
<td>5 point scale from 2 = like very much to -2 = dislike very much</td>
<td>Fruit: 0.844 Vegetables: -</td>
</tr>
<tr>
<td>Which of the following fruits do you like or dislike? List of 12 fruits: apple, banana, pear, orange, tangerine, plum, peach, melon, strawberry, grapes, cherries, kiwi.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Vegetables preferences
Which of the following vegetables do you like or dislike: List of 12 vegetables: tomato, cucumber, lettuce, cabbage, spinach, leak, green beans, onion, carrot, broccoli, cauliflower, green peas.

<table>
<thead>
<tr>
<th>5 point scale from 2 = like very much to -2 = dislike very much</th>
<th></th>
</tr>
</thead>
</table>

### Perceived barriers
I do not eat fruit / vegetables because:
It takes too much time to eat.
I want to eat something else.
My fingers get sticky when I eat it. (just for fruit)
It gets squeezed in the school bag.
I am still hungry after eating them.

<table>
<thead>
<tr>
<th>5 point scale from 2 = I fully agree to -2 = I fully disagree</th>
<th></th>
</tr>
</thead>
</table>

### Perceived availability at home
Are there usually different kinds of fruits / vegetables available in your home?
If you tell at home what fruit / which vegetables you would like to eat, will it be bought?
Are there usually fruits / vegetables available at home that you like?
Is there usually a fruit bowl (or similar) in the kitchen or living room?
In your home, are there usually vegetables served with dinner (or lunch)?
Are the vegetables at dinner / lunch in your home usually served in a way that you like (e.g. raw, cooked)?

<table>
<thead>
<tr>
<th>5 point scale from 2 = I fully agree to -2 = I fully disagree</th>
<th></th>
</tr>
</thead>
</table>

### Perceived availability at school
Can you get fruit / vegetables at school either by buying it or getting it for free?

<table>
<thead>
<tr>
<th>5 point scale from 2 = I fully agree to -2 = I fully disagree</th>
<th>N/A</th>
</tr>
</thead>
</table>

### Perceived availability at friends' house
Can you get fruit / vegetables at your friends' house, when you spend the afternoon there?

<table>
<thead>
<tr>
<th>5 point scale from 2 = I fully agree to -2 = I fully disagree</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Perceived availability at leisure</strong></td>
<td></td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Can you get fruit / vegetables at the place where you have your leisure time activity (e.g. club, sports place), either by buying it or getting it for free?</td>
<td>5 point scale from 2 = I fully agree to -2 = I fully disagree</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Modeling</strong></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>My mother eats fruit / vegetables every day.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>My father eats fruit / vegetables every day.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>My best friends eat fruit / vegetables every day.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I often eat fruit / vegetables together with my family.</td>
<td>5 point scale from 2 = I fully agree to -2 = I fully disagree</td>
<td>0.548</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Parental facilitation</strong></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Does your mother or father usually cut up fruit / vegetables for you in between meals?</td>
<td>5 point scale from 2 = I fully agree to -2 = I fully disagree</td>
<td>N/A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Bring to school</strong></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you usually bring fruit / vegetables with you to school?</td>
<td>5 point scale from 2 = I fully agree to -2 = I fully disagree</td>
<td>N/A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Parental encouragement</strong></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>My mother encourages me to eat fruit / vegetables every day.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>My father encourages me to eat fruit / vegetables every day.</td>
<td>5 point scale from 2 = I fully agree to -2 = I fully disagree</td>
<td>0.548</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Parental demand</strong></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Do your parents demand that you eat fruit / vegetables every day?</td>
<td>5 point scale from 2 = I fully agree to -2 = I fully disagree</td>
<td>N/A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Parental allowance</strong></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Are you allowed to eat as much fruit / as many vegetables as you like at home?</td>
<td>5 point scale from 2 = I fully agree to -2 = I fully disagree</td>
<td>N/A</td>
</tr>
</tbody>
</table>

N/A not applicable
Results

Sample characteristics

Table 2 presents the characteristics of the socio-demographic variables for the intervention and control groups. The mean age was 11.2 years for the intervention and 11.3 years in the control group. Similar proportion of boys and girls participated in the study. A significant difference was observed for family educational level between intervention and control groups. This was considered a confounder and controlled for in all analyses to determine the intervention effect.

<table>
<thead>
<tr>
<th></th>
<th>Intervention group</th>
<th>Control group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects (n)</td>
<td>310</td>
<td>380</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>11.2</td>
<td>11.3</td>
<td>0.343</td>
</tr>
<tr>
<td>SD</td>
<td>0.5</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Boys (n)</td>
<td>150</td>
<td>204</td>
<td></td>
</tr>
<tr>
<td>Boys (%)</td>
<td>48.4</td>
<td>53.7</td>
<td>0.154</td>
</tr>
<tr>
<td>Family structure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Families (n)</td>
<td>269</td>
<td>349</td>
<td></td>
</tr>
<tr>
<td>Subject lives with both own parents (%)</td>
<td>81.5</td>
<td>85.7</td>
<td>0.135</td>
</tr>
<tr>
<td>Subject does not live with both own parents (%)</td>
<td>18.5</td>
<td>14.3</td>
<td></td>
</tr>
<tr>
<td>Subject lives with two adults (%)</td>
<td>87.7</td>
<td>92.8</td>
<td></td>
</tr>
<tr>
<td>Single parent family</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subject lives only with his/her father (%)</td>
<td>1.3</td>
<td>1.1</td>
<td>0.770</td>
</tr>
<tr>
<td>Subject lives only with his/her mother (%)</td>
<td>11.0</td>
<td>6.1</td>
<td>0.014</td>
</tr>
<tr>
<td>Family educational level (n)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 7 years (%)</td>
<td>46.5</td>
<td>61.0</td>
<td></td>
</tr>
<tr>
<td>7 - 9 years (%)</td>
<td>34.6</td>
<td>29.8</td>
<td>0.001</td>
</tr>
<tr>
<td>10- 12 years (%)</td>
<td>2.6</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>&gt; 12 years (%)</td>
<td>16.4</td>
<td>6.9</td>
<td></td>
</tr>
</tbody>
</table>

Table 3 shows the mean frequency of intake of fruit, vegetables and combined fruit and vegetables (in times per day) as well as mean intakes (in grams per day) for fruit, vegetables, soup, combined fruit and vegetables and fruit and vegetables plus soup at baseline level by intervention arms. Significant differences were observed at baseline for vegetable intake (g/d), as well as for total FV intake without considering soup (g/d)
and FV intake (times/d), in which the intervention group showed a higher consumption / frequency of consumption when compared to the control group.

**Table 3. Mean frequency of intake and total mean intake at baseline for the Intervention (n 310) and control group (n 380)**

<table>
<thead>
<tr>
<th></th>
<th>Intervention (n 310)</th>
<th>Control (n 380)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SE</td>
<td>Mean</td>
</tr>
<tr>
<td><strong>Intake (times/day)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit</td>
<td>1.04</td>
<td>0.05</td>
<td>0.92</td>
</tr>
<tr>
<td>Vegetables</td>
<td>1.67</td>
<td>0.09</td>
<td>1.48</td>
</tr>
<tr>
<td>Fruit and vegetables</td>
<td>2.71</td>
<td>0.12</td>
<td>2.41</td>
</tr>
<tr>
<td><strong>Intake (grams/day)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit</td>
<td>146.8</td>
<td>7.54</td>
<td>131.0</td>
</tr>
<tr>
<td>Vegetables excluding soup</td>
<td>57.4</td>
<td>3.88</td>
<td>44.6</td>
</tr>
<tr>
<td>Soup</td>
<td>61.6</td>
<td>3.72</td>
<td>69.2</td>
</tr>
<tr>
<td>Fruit and vegetables</td>
<td>204.2</td>
<td>9.23</td>
<td>175.6</td>
</tr>
<tr>
<td>Fruit and vegetables plus soup</td>
<td>265.8</td>
<td>11.12</td>
<td>244.8</td>
</tr>
</tbody>
</table>

*P value estimated by Student's t test difference in mean intake between intervention and control groups at baseline
SE standard error

**Primary outcome: group differences in FV consumption**

Table 4 presents intervention effects on FV intake. Differences between intervention and control groups were found for the intake (g/day): children who participated in the intervention were significantly more likely to have higher intakes of vegetables, soup, fruit and vegetables and fruit and vegetables plus soup, whereas no differences were found in the frequencies of intake.

**Secondary outcome: Correlates of FV intake**

The results of the GLM Univariate analyses for fruit are shown in Table 5a and for vegetables in table 5b.

**Fruit:** Four personal factors yielded significance: intervention students had a higher evolution on knowledge, liking, preferences and perceived barriers. The remaining factors (self-rated intake, self-rated intake compared to other children, attitude, general self-efficacy, intention and habit) were not statistically different between intervention and control students.
Table 4. Intervention effect on fruit and vegetable intake*

<table>
<thead>
<tr>
<th>Intake (times/day)</th>
<th>Intervention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
</tr>
<tr>
<td>Fruit</td>
<td>267</td>
<td>1.02</td>
</tr>
<tr>
<td>Vegetables</td>
<td>263</td>
<td>1.56</td>
</tr>
<tr>
<td>Fruit and vegetables</td>
<td>263</td>
<td>2.61</td>
</tr>
<tr>
<td>Fruit evolution</td>
<td>263</td>
<td>0.07</td>
</tr>
<tr>
<td>Vegetables evolution</td>
<td>263</td>
<td>0.08</td>
</tr>
<tr>
<td>Fruit and vegetable evolution</td>
<td>263</td>
<td>0.15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intake (grams/day)</th>
<th>Intervention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
</tr>
<tr>
<td>Fruit</td>
<td>268</td>
<td>168.7</td>
</tr>
<tr>
<td>Vegetables excluding soup</td>
<td>268</td>
<td>66.4</td>
</tr>
<tr>
<td>Soup</td>
<td>268</td>
<td>76.1</td>
</tr>
<tr>
<td>Fruit and vegetables</td>
<td>268</td>
<td>231.9</td>
</tr>
<tr>
<td>Fruit and vegetables plus soup</td>
<td>268</td>
<td>307.4</td>
</tr>
</tbody>
</table>

* Means are adjusted for baseline measures, age and parental education as covariates. Gender as a fixed factor. SE Standard error

Table 5a. Evolution of potential determinants of fruit intake*

<table>
<thead>
<tr>
<th>Personal</th>
<th>Intervention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
</tr>
<tr>
<td>Self-rated intake</td>
<td>266</td>
<td>0.03</td>
</tr>
<tr>
<td>Self-rated intake compared to other children</td>
<td>264</td>
<td>-0.02</td>
</tr>
<tr>
<td>Knowledge</td>
<td>266</td>
<td>0.73</td>
</tr>
<tr>
<td>Attitude</td>
<td>267</td>
<td>-0.09</td>
</tr>
<tr>
<td>Liking</td>
<td>259</td>
<td>-0.16</td>
</tr>
<tr>
<td>General self-efficacy</td>
<td>265</td>
<td>0.07</td>
</tr>
<tr>
<td>Intention</td>
<td>262</td>
<td>-0.07</td>
</tr>
<tr>
<td>Habit</td>
<td>262</td>
<td>-0.16</td>
</tr>
<tr>
<td>Preferences</td>
<td>258</td>
<td>0.05</td>
</tr>
<tr>
<td>Perceived barriers</td>
<td>265</td>
<td>0.23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social environment</th>
<th>Intervention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
</tr>
<tr>
<td>Modelling</td>
<td>267</td>
<td>-0.05</td>
</tr>
<tr>
<td>Parental facilitation</td>
<td>256</td>
<td>0.10</td>
</tr>
<tr>
<td>Active Parental encouragement</td>
<td>257</td>
<td>0.29</td>
</tr>
<tr>
<td>Parental demand</td>
<td>253</td>
<td>0.33</td>
</tr>
<tr>
<td>Parental allowance</td>
<td>241</td>
<td>0.09</td>
</tr>
<tr>
<td>Bring fruit to school</td>
<td>266</td>
<td>0.35</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical environment</th>
<th>Intervention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
</tr>
<tr>
<td>Perceived availability at home</td>
<td>262</td>
<td>0.20</td>
</tr>
<tr>
<td>Perceived availability at school</td>
<td>266</td>
<td>0.30</td>
</tr>
<tr>
<td>Perceived availability at friends' house</td>
<td>259</td>
<td>0.09</td>
</tr>
<tr>
<td>Perceived availability at leisure</td>
<td>165</td>
<td>0.26</td>
</tr>
</tbody>
</table>

* Means are adjusted for baseline measures, age and parental education as covariates. Gender as a fixed factor. SE standard Error
At the social environmental level, there was a significant increase in the evolution of parental facilitation, parental demand and to bring fruit to school in schoolchildren from the intervention compared to those from the control. No differences between groups were found for the evolution on modelling, active parental encouragement and parental allowance.

In what concerns physical environment factors, the perceived availability at home raised in the intervention students, whereas the perceived availabilities at school and at friends’ house decreased. No differences were found for the evolution on the perceived availability at leisure between intervention and control students.

| Table 5b. Evolution of potential determinants of vegetable intake* |
|------------------|----------|----------|----------|----------|----------|----------|
|                  | Intervention | Control  |
|                  | n    | Mean  | SE    | n    | Mean  | SE    | P       |
| **Personal**     |       |       |       |       |       |       |         |
| Self-rated intake| 263  | -0.09 | 0.06  | 342  | -0.05 | 0.06  | 0.603   |
| Self-rated intake compared to other children| 260  | -0.07 | 0.06  | 340  | -0.08 | 0.05  | 0.863   |
| Knowledge        | 263  | 0.25  | 0.12  | 338  | -0.37 | 0.11  | <0.001  |
| Attitude         | 258  | -0.15 | 0.06  | 340  | -0.25 | 0.06  | 0.268   |
| Liking           | 256  | -0.22 | 0.07  | 340  | -0.29 | 0.06  | 0.443   |
| General self-efficacy | 261  | -0.08 | 0.06  | 340  | -0.09 | 0.05  | 0.873   |
| Intention        | 261  | -0.15 | 0.08  | 340  | -0.28 | 0.07  | 0.203   |
| Habit            | 258  | -0.60 | 0.08  | 340  | -0.18 | 0.07  | 0.256   |
| Preferences      | 226  | -0.12 | 0.06  | 314  | -0.07 | 0.05  | 0.461   |
| Perceived barriers| 260  | 0.10  | 0.07  | 338  | 0.07  | 0.06  | 0.744   |
| **Social environment** |       |       |       |       |       |       |         |
| Modelling        | 261  | 0.07  | 0.05  | 340  | -0.02 | 0.04  | 0.212   |
| Parental facilitation | 252  | 0.19  | 0.09  | 341  | -0.01 | 0.07  | 0.080   |
| Active Parental encouragement | 255  | 0.31  | 0.08  | 336  | 0.02  | 0.07  | 0.005   |
| Parental demand  | 256  | 0.20  | 0.08  | 342  | 0.05  | 0.07  | 0.169   |
| Parental allowance| 257  | 0.15  | 0.07  | 342  | 0.04  | 0.06  | 0.203   |
| Bring vegetables to school | 260  | 0.23  | 0.05  | 344  | 0.06  | 0.05  | 0.018   |
| **Physical environment** |       |       |       |       |       |       |         |
| Perceived availability at home| 255  | 0.19  | 0.05  | 342  | 0.06  | 0.04  | 0.048   |
| Perceived availability at school| 260  | 0.01  | 0.10  | 344  | 0.53  | 0.08  | <0.001  |
| Perceived availability at friends’ house| 257  | -0.02 | 0.09  | 336  | 0.15  | 0.10  | 0.207   |
| Perceived availability at leisure| 147  | 0.21  | 0.13  | 204  | 0.22  | 0.11  | 0.958   |

* Means are adjusted for baseline measures, age and parental education as covariates. Gender as a fixed factor.
SE standard Error

**Vegetables:** Changes in vegetable correlates were generally less expressive than those in fruit correlates. Only one personal factor yielded significance: the evolution on
knowledge was significantly higher in the intervention students. The remaining scores, although higher in the intervention than in the control group were not statistically different.

At social environmental level, there were significant increases in active parental encouragement and to bring vegetables to school. Similarly to fruit correlates, there was a positive and higher evolution in the perceived availability at home in the intervention students, whereas the perceived availability at school decreased.

Discussion

This study was a controlled evaluation of a multi-component theory-based FV intervention implemented with 11-year-old schoolchildren across approximately 7 months, and evaluated incremental changes in FV consumption and their correlates. To our knowledge this was the first multi-component healthy eating promotion initiative in Portugal, based on different behavioural theories\textsuperscript{24} that only focused on fruit and vegetables and was evaluated with a rigorous scientific method. Daily intakes of fruit and vegetables were in line with data from a previous study with a representative sample\textsuperscript{15}, reinforcing the idea that a large proportion of Portuguese children are below the recommended levels of intake.

Our study confirms that behaviour change is difficult to achieve – although there were changes in consumption (the intervention group had a significantly higher consumption of fruit and vegetables when compared to the control group), those changes were small in magnitude (increases around 10 to 40 grams per day). These results are in agreement with the findings from a recent review that found an increase by one quarter to one-third of a portion, equivalent to 20-30 grams of daily consumption increase\textsuperscript{30}. Although the frequency of fruit and vegetable consumption had a slight increase in the intervention group, these results were not significant. Following children for longer periods may be required to capture the full benefit of the intervention on behaviour change. Also, it is worth considering the adoption of additional intervention strategies to further increase FV consumption. For instance, it
might be important to consider changes in the schools’ food environment and possibly provide mixed approaches like a multicomponent intervention combined with free provision of fruit and vegetables, as well as to enrol other potential supporters such as local producers, the media and food industries.

Although the frequency of vegetable consumption was higher than the fruit consumption, vegetable intake (grams per day) was clearly lower than fruit intake. These data are also in agreement with previous studies\textsuperscript{15,31,32}. We can hypothesize that the frequency was higher due to vegetables’ presence in the main meals of lunch and dinner, usually represented by soup.

From our results, it is important to highlight the soup contribution for the total consumption of vegetables in children: Portugal has one of the major soup consumption levels among European countries and it is known that soup consumption is very important as a mean to increase vegetable intake\textsuperscript{15}, to decrease the energy density of the diet\textsuperscript{33} and to prevent obesity\textsuperscript{34}. Thus, soup should be broadly promoted in Portuguese schools, namely through workshops, price campaigns at school canteen, educational sessions to develop cooking skills and taste sessions. It is also important to know if the soup provided at schools is well accepted by children.

In what concerns personal correlates of fruit and vegetables, there was a significant increase in children’s knowledge of the recommendations for FV intake in the intervention group. These knowledge gains may, to some extent, indicate program effectiveness and suggest that messages have reached the children. This also suggests that increasing nutritional education, which includes skills necessary for preparing fruit and vegetables for consumption, might increase their intake.

For fruit, but not for vegetables, liking and preferences showed to have a favourable and significant evolution in the intervention group. More exposure could therefore provide a mean to modify acceptance of initially rejected or disliked foods. It is also known that fruit intake is more likely to be reported by children with positive liking for fruit, with more knowledge on the recommended levels and with a higher preference for many different fruits\textsuperscript{35}.

Somewhat, the intervention group had a significant increase in the perceived barriers of fruit intake compared to the control group. This may be related to the fact that these children, due to the intervention program, were more aware of the reasons that
prevent them from consuming fruit and therefore had a greater perception of the barriers of consumption.

Relating to social environmental correlates, promising results were found: there was a significant increase in some of them, namely on parental demand (only for fruit), parental facilitation (only for fruit), parental encouragement (only for vegetables) and bringing fruit and vegetables to school. A cross-European study showed that parental demand and facilitation to eat fruit and vegetables were associated with higher consumption in schoolchildren and that parental encouragement was associated with vegetable intake, with no associations between verbal encouragement and fruit intake\textsuperscript{36}. This means that one of the most challenging goals\textsuperscript{37} of this kind of programs was partly achieved: it was possible, to some extent, to get parents involved and influence home consumption practices.

It is known that one of the most influential determinants of children’s FV consumption is their parents\textsuperscript{38}. Parents make decisions about the types of foods that are offered to their children based on their own attitudes and beliefs about food. Consequently, a child’s food choice is mostly influenced by the range of foods provided by his/her parents and the availability of fruit and vegetables in the home is likely to be an antecedent to consumption. Children whose parents eat plenty of fruit and vegetables and who attempt to provide a home environment where fruit and vegetables are part of the regular diet have been reported to eat more of these foods than other children\textsuperscript{39-41}.

Nonetheless, no results were found for modelling or parental allowance, which means that more efforts are needed at this level. Particularly for children, eating is a social behaviour\textsuperscript{42} where they tend to observe the eating behaviours of others, particularly of their parents and possibly modify their own\textsuperscript{43}. Perceived parental modelling is known to be a predictor of daily FV intake\textsuperscript{40,44-46}.

At physical environmental level, there was a significant increase in the perceived availability of fruit and vegetables at home in the intervention group, whereas a significant decrease in the perceived availability at school (both for fruit and vegetables) and at friends’ house (only for fruit) was observed. Once again, the possible explanation lies in the fact that intervention students might had an increased perception of the difficulties to get different fruit and vegetables at school and at
friends’ house compared to those from the control group, due to the increased awareness brought by the intervention program to these children. A considerable number of studies showed a positive association between availability and FV intake\textsuperscript{44,47-49}. Also noteworthy is the fact that there were generally higher scores on fruit intake scales that on vegetables ones. This means that children had a more positive attitude towards fruit than vegetables\textsuperscript{50} and that vegetable consumption is more difficult to improve. First of all, fruits are more appealing to children: many fruits have a sweet taste (for which humans have an innate liking) and greater energy density\textsuperscript{51}. Second, in Western countries, it is much more common to eat fruit than vegetables between meals.

In fact, and like other studies\textsuperscript{52,53}, most of the effects of this program appeared to be on fruit intake rather than on vegetable intake. It is therefore important to consider which future strategies should be used in future intervention programs. Possibly, and as stated by other authors, approaches addressing fruit promotion and vegetable promotion separately are worth considering\textsuperscript{54}.

**Limitations**

The study has some limitations that must be acknowledged. First, Portuguese data derives from a convenience sample that is not representative of the population, which means that there is potential for selection bias. Second, data were collected by self-report, and these data may be subject to a number of biases such as desirability or poor recall. Third, the follow-up period was relatively short. The evaluation has been conducted immediately after the intervention, while it is known to be essential to have measures of at least 6 months after the intervention to be able to study the retention of behaviour changes\textsuperscript{55}. In such a short time span, large differences could not be expected. A small change in intake will be a limiting factor for observing relations between change in intake and its determinants. Additionally the low level of knowledge about the recommended intakes may lead to overestimation of intake in the questionnaire. Further limitations include that only a single record of a weekday for the 24-hour-recall was performed thus showing its possible inability to reflect the
usual intake; relating to scales, there were few items per scale, but in a questionnaire
development there is always a trade-off between precision and extensiveness\textsuperscript{29}.

\textbf{Strengths}

Our study included a well drawn and established multi-component intervention, with
activities at classroom, school and family levels. The intervention has involved family
members in an active way, schools, teachers and health and nutrition experts that are
known to enhance the effectiveness of programs targeting children\textsuperscript{56}. We’ve used a
standardized and validated instrument to measure FV intake and potential personal,
social and environmental correlates. As family socio-economic position, namely
parental education, is known to be associated with children’s diet\textsuperscript{57}, we took into
account the possible effects of parental educational level. Furthermore, to solve the
problem of baseline differences in intake between groups, we adjusted all analyses for
baseline differences. Although convenient, sample had a large size and a high
participation rate.

\textbf{Conclusion}

This study provides information for public health policy makers and practitioners,
particularly in Portugal, regarding strategies to facilitate the implementation and
evaluation of health promotion programs on FV consumption.

Since the intervention effect is expected to decrease over time\textsuperscript{58,59}, longer-term follow-
up evaluation is needed in order to determine whether the intervention impact is
sustained in time.

Taking into account that children’s appreciation of health promoting programs seems
to be associated with the intervention effects\textsuperscript{28,60}, there is a strong need for
information regarding their opinion on these programs.
Acknowledgments

The Pro Greens project was supported by a financial contribution from the Programme of Community Action in the Field of Public Health 2003-2008 from the European Commission. The authors would like to thank the participating children, their parents and headmasters, teachers and staff that have worked on the Pro Greens project in Portugal.

References


Personal, social and environmental predictors of fruit and vegetable consumption in 11-year-old Portuguese schoolchildren

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[Submitted for publication]

Abstract

Objective: To test personal, social and physical environmental determinants of fruit and vegetable intake in 11-year-old schoolchildren and the way these determinants alter across one school year.

Design: The analysis was based on data from the European study Pro Greens. Participants from intervention and control schools completed, prior and after an intervention, a self-administered questionnaire with questions on demographics, fruit and vegetable intake and personal, social and physical environmental determinants of fruit and vegetable consumption. Two sets of hierarchical regression analyses were performed to determine the explained variance of children’s fruit and vegetable intake.

Setting: Primary schools from the North region of Portugal.

Subjects: Portuguese participants (n 690) of the Pro Greens study, 6th graders.

Results: Lower baseline intake, favourable change on habit, former habit at baseline as well as less perceived barriers between follow-up and baseline periods were the strongest determinants of higher change on fruit intake. For vegetables, lower baseline intake, negative attitudes towards vegetables at baseline, liking vegetables at baseline and higher evolution on knowledge emerged as the strongest determinants of higher change on vegetable intake. 40-7% and 47-2% of the variance in children’s fruit and vegetable intake, respectively, was explained by the model.
Conclusions: Our findings highlight the importance of using different approaches for the promotion of fruit and vegetable consumption, since these behaviours are distinct and influenced by different factors.

Keywords: School-based intervention; Children; Determinants; Fruit and vegetables

Introduction

Encouraging healthy eating behaviours in early life stages is a way to prevent diet-related diseases. In the particular case of fruit and vegetable consumption, it is known that an adequate intake has potential to reduce the risk of cancer\(^1\-^3\), hypertension\(^4\), type 2 diabetes\(^1\,^5\), cardiovascular disease\(^6\-^8\), and may contribute to body weight reduction\(^9\).

Despite the potential to improve overall health, daily intake of fruit and vegetables remains below the recommended levels in most Western Countries. As shown in a cross-European Study involving 9 countries, fruit and vegetable intake is lower than the national guidelines of each country\(^10\). Results from the Health Behaviour in School-aged children Study Report 2009/2010\(^11\) show that in 11-year-olds only 57% and 44% of Portuguese girls and boys, respectively, eat fruit daily. The results are even worse in what concerns vegetable intake: about 35% of the girls and less than one third of the boys consume vegetables daily.

To develop effective interventions to increase fruit and vegetable consumption one needs to get insight into the etiological processes and to identify potentially modifiable mediators or determinants of consumption patterns. To ensure the inclusion of these potential determinants, health promotion state-of-art advises a problem-driven and theory-driven approach, with constructs from different behavioural theories\(^12\).

Pro Greens, a follow-up of the Pro Children project\(^13\), was designed to assess fruit and vegetable consumption before and after an intervention and to promote fruit and vegetable intake in European schoolchildren. In these projects, the inclusion of potential determinants was made by means of a systematic literature review\(^14\), focus groups with schoolchildren\(^15\) and also taking into account different behavioural
theories as Flay’s Theory of Triadic Influences\textsuperscript{[16]}, the Attitude – Social influence – self-Efficacy (ASE)\textsuperscript{[17]} model and Social Cognitive Theory\textsuperscript{[18]}. Flay’s Theory of Triadic Influences\textsuperscript{[16]} encompasses different levels of causation: proximal, distal and ultimate causes of behaviour. This theory emphasizes that more distal determinants of fruit and vegetable consumption can be found in the cultural, physical and social environment, and that these, in turn, influence more proximal personal influences of attitude, social influences and self-efficacy. The ASE-model \textsuperscript{[17]} proposes that fruit and vegetable consumption is primarily a function of motivation or intentions. Three main psychosocial factors have been identified as predictors of intentions: attitudes, social influence and self-efficacy. A person’s attitude towards fruit and vegetable consumption is a result of the expected consequences from this behaviour. Social influence is a result of subjective norms, examples from important others (modelling) and direct social support and pressure related to fruit and vegetable intake. Self-efficacy is the result of a person’s subjective assessment of his or her abilities and possibilities related to fruit and vegetable intake. In the final model, Pro Greens included distinct levels of determinants: demographic (considered the most distal ones), physical environmental, social environmental and personal determinants (the most proximal ones). Besides being important to understand the underlying mechanisms related to fruit and vegetable consumption (i.e. to gain insight into important correlates of consumption), it is also important to find out which factors are most related to children’s change in fruit and vegetable consumption. It seems important to understand which strategies can be more effective to alter behaviours. Particularly, it would be of special interest to find out which children could have an increased benefit with an intervention project. The aim of the present study was to test personal, social and physical environmental determinants of 11-year-old schoolchildren’s fruit and vegetable intake and the way these determinants and behaviours alter across one school year.
Methods

Design and sampling

The study described in this paper uses data from the European Pro Greens multi-component, theory-based study (www.progreens.org). 10 European countries were involved in this study: Bulgaria, Finland, Germany, Greece, Iceland, Norway, Portugal, Slovenia, Sweden and the Netherlands. Only data from the Portuguese sample will be presented.

Five primary schools from the North of Portugal were invited to participate. Approval to contact the schools was obtained from the Portuguese Ministry of Education. None of the schools contacted refused the voluntary participation; schools were then assigned to the intervention and control arms of the study. A total of 1004 sixth graders from 41 classes were eligible to participate.

A multicomponent intervention was carried out in two schools from November 2009 to May 2010. The intervention consisted of:

a classroom component (all participants received a set of guided worksheets to increase knowledge, awareness and skills regarding fruit and vegetables. Some of the activities were carried out during school hours with teachers’ supervision, while others were suggested as homework to develop with family members. Teachers involved in the project had previous information and training on these activities);

a school component (several educational sessions with children and teachers and the development of a blog entitled City of Greens to reinforce the knowledge on fruit and vegetables through some playful didactic activities and also visits to local markets and supermarkets to promote contact with different fruits and vegetables);

a family component (involving caregivers in children’s homework assignments and providing educational sessions to give tips to encourage their children to eat more fruit / vegetables; information on the study and its activities was sent regularly to all the families involved in the project).

The assessment was made by means of two distinct measurements. For the baseline (May 2009) and follow-up (May 2010) measurements, schoolchildren had to complete, during school hours, a self-administered questionnaire with written instructions in the presence of a teacher and, in some cases, a project researcher. One school lesson was
used to complete each questionnaire that contained questions on demographics, fruit and vegetable intake and personal, social and physical environmental determinants of fruit and of vegetable consumption. A questionnaire for the parents (to be filled by one of the parents) was given to the children to take home. Prior to this, parents were reached by mail or through the class teacher in order to provide written informed consent for their child and for themselves.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Scientific Committee of the Faculty of Nutrition and Food Sciences.

**Baseline sample**

Due to illness or absence at the first collection ($n \ 11$), lack of active participation by one classroom ($n \ 25$) or lack of informed consent ($n \ 26$), only 942 children out of 1004 were included in the baseline measurements. Additionally, 37 questionnaires were returned empty, 6 lacked information on the 24-hour recall part of the questionnaire and 1 had missing information on gender. A total of 898 children were included in the baseline analyses.

Also, 618 parents delivered complete questionnaires. Parent and child data were matched with a common ID.

**Follow-up sample**

864 children were present at the second data collection: 57 delivered empty questionnaires; 14 questionnaires were not returned; 3 questionnaires had missing data on gender and 1 did not present gender information; an additional 5 questionnaires were considered unreliable and 40 had incomplete or missing answers in the 24-hour recall part. The final sample consisted of 744 schoolchildren.

In summary, 898 students participated and have correctly completed the survey at baseline (89.4% response rate) and 744 students completed the follow-up questionnaire (74.1% response rate). Only data from children that had completed both the baseline and the follow-up questionnaire will be presented ($n \ 690; n_{\text{intervention}} \ 310; n_{\text{control}} \ 380$). Since there was missing data for some of the variables, the number
differed slightly between analyses, as indicated further in the result section of this paper.

**Instrument**

An adapted version of the Pro Children questionnaire was used to assess fruit and vegetable intake among schoolchildren and to identify the determinants of consumption. An English version of the questionnaire can be found at www.progreens.org.

The questionnaire comprised two major sections: the dietary part was composed of a precoded 24-hour recall and a food frequency questionnaire (FFQ). Fruit and vegetable intake was assessed in the FFQ by four questions on usual intake of fresh fruit, salad or grated vegetables, other raw vegetables and cooked vegetables (including soup). Each question had eight response categories ranging from “never” to “every day, more than twice a day”. Data from the 24-hour recall wasn’t used for analyses purposes in this paper. Only data from the FFQ will be presented.

The determinant part of the questionnaire aimed to measure several constructs that were the same for fruit and for vegetable intake, although they’ve been measured separately. Eighteen determinants of fruit intake and vegetable intake were included (Table 2). All constructs, except knowledge, were assessed with a five-point scale ranging from fully disagree (-2) to fully agree (+2). Higher values reflected more positive determinant for fruit or for vegetable intake. The question on the knowledge of the recommended levels comprised an 8-point scale, with response options ranging from “no fruit or vegetables” to “5 pieces or portions per day or more”.

Both the dietary and determinant sections of the questionnaire were found to be reliable and valid^{(19, 20)}.

As part of the demographics questionnaire, age (calculated with the year and month of birth) and sex were included in the present study.

Parents’ questionnaire was only applied at the first data collection; it provided socio demographic information, namely on parental educational level, that was used for analytical purposes in this study.
Data analysis

Descriptive statistics were calculated for socio-demographic variables (sex, age and parental educational level) and for the frequency of fruit and vegetable intake and their potential determinants at baseline level. Additionally, descriptive statistics were used to calculate the change between baseline and follow-up in the independent variables. To determine the change in the frequency of intake of fruit and vegetables as well as in their potential determinants, net differences between baseline and follow-up for the mean frequency of intake and the mean score of the determinants were calculated, both for intervention and control groups.

The answers from the FFQ were converted in estimated number of times per day. Afterwards we recoded the result back to the original scale of the answers (ranging from never to every day, more than twice).

Differences between groups were explored with $\chi^2$ or Mann-Whitney U tests both for baseline and change values.

Spearman’s correlation between all independent variables was computed to show the non-adjusted relationship between each variable and intake of fruit and vegetables, separately.

To determine the explained variance of schoolchildren’s fruit and vegetable intake, hierarchical linear regression analyses were performed. Two sets of multiple regression analysis were conducted, one for fruit and one for vegetables.

In the first block of the analyses, we’ve used the method enter to include the baseline values (for fruit intake and for vegetable intake), group (intervention and control), age, gender and parental educational level.

In the second block, we’ve used the method enter to include the baseline values of the independent variables.

In the third block a backward method to the previous baseline variables was applied. We’ve entered the scores of change in the fourth block. In the fifth block another backward method was performed for the scores of change.

Standardized betas were used to compare the adjusted associations of the different potential correlates with intake. For the last step of each block presented, the adjusted variance explained (adjusted $R^2$) is given.

Statistical analyses were conducted using the IBM SPSS Statistics 20.00.
A p-value <0.05 was considered to be significant.

Results

Table 1 describes the socio-demographic characteristics of the participant children by intervention arm.

**Table 1. Characteristics of the study sample by intervention arm: children (n 690) from the Portuguese sample of the Pro Greens study**

<table>
<thead>
<tr>
<th></th>
<th>Intervention group</th>
<th>Control group</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects (n)</td>
<td>310</td>
<td>380</td>
<td></td>
</tr>
<tr>
<td>Boys (n)</td>
<td>150</td>
<td>204</td>
<td></td>
</tr>
<tr>
<td>Boys (%)</td>
<td>48.4</td>
<td>53.7</td>
<td>0.154</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>11.19</td>
<td>11.27</td>
<td>0.343</td>
</tr>
<tr>
<td>SD</td>
<td>0.53</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>Family educational level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n)</td>
<td>269</td>
<td>349</td>
<td></td>
</tr>
<tr>
<td>&lt; 7 years (%)</td>
<td>46.5</td>
<td>61.0</td>
<td></td>
</tr>
<tr>
<td>7 - 9 years (%)</td>
<td>34.6</td>
<td>29.8</td>
<td>0.001</td>
</tr>
<tr>
<td>10-12 years (%)</td>
<td>2.6</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>&gt; 12 years (%)</td>
<td>16.4</td>
<td>6.9</td>
<td></td>
</tr>
</tbody>
</table>

Mean scores on the potential determinants and intake of fruit and vegetables are presented at Tables 2 and 3, respectively, at baseline and for the change between baseline and follow-up period, by intervention arm.

**Fruit scores:** At baseline, the intervention group had slightly but significant higher scores on the following determinant scales (all \( P<0.05 \)): attitudes, active parental encouragement, parental demand and allowance, parental facilitation, availability at home and at leisure. Furthermore, the intervention group had significantly higher intake at the baseline (mean\(_{\text{intervention}} = 4.21\) (SD 1.73); mean\(_{\text{control}} = 3.91\) (SD 1.79); \( P < 0.05 \)).

Baseline scores on fruit preferences and availability of fruit at school were significantly lower in the intervention compared to the control group.
Regarding the score changes (difference between follow-up and baseline measurements) for fruit, the intervention group had significant higher results for knowledge, preferences, to bring fruit to school and availability at home. Scores for liking were lower compared to the control group ($P<0.05$).

**Vegetable scores:** Scores on the potential determinants for vegetables were generally lower than fruit scores, thus showing that children had less positive behaviours towards vegetables than fruit.

At baseline, intervention group had significantly higher scores on parental demand and allowance and availability at home.
Table 2. Mean scores and SD on the determinants and intake for fruit at baseline and their change between baseline and follow-up, by intervention arm

<table>
<thead>
<tr>
<th></th>
<th>Intervention</th>
<th>Baseline</th>
<th>Control</th>
<th>Intervention</th>
<th>Change</th>
<th>Control</th>
</tr>
</thead>
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<tr>
<td></td>
<td>n</td>
<td>Mean</td>
<td>SD</td>
<td>n</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Knowledge</td>
<td>309</td>
<td>0.72</td>
<td>0.45</td>
<td>380</td>
<td>0.68</td>
<td>0.47</td>
</tr>
<tr>
<td>Attitudes</td>
<td>310</td>
<td>1.77*</td>
<td>0.51</td>
<td>380</td>
<td>1.64*</td>
<td>0.66</td>
</tr>
<tr>
<td>Liking</td>
<td>305</td>
<td>1.57</td>
<td>0.64</td>
<td>372</td>
<td>1.46</td>
<td>0.80</td>
</tr>
<tr>
<td>General self-efficacy</td>
<td>308</td>
<td>1.29</td>
<td>0.85</td>
<td>380</td>
<td>1.17</td>
<td>0.93</td>
</tr>
<tr>
<td>Intention</td>
<td>307</td>
<td>1.34</td>
<td>0.92</td>
<td>379</td>
<td>1.28</td>
<td>1.01</td>
</tr>
<tr>
<td>Habit</td>
<td>307</td>
<td>1.05</td>
<td>1.11</td>
<td>379</td>
<td>0.97</td>
<td>1.21</td>
</tr>
<tr>
<td>Preferences</td>
<td>301</td>
<td>1.28*</td>
<td>0.63</td>
<td>367</td>
<td>1.38*</td>
<td>0.61</td>
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<tr>
<td>Perceived barriers</td>
<td>308</td>
<td>-1.29</td>
<td>0.89</td>
<td>375</td>
<td>-1.28</td>
<td>0.82</td>
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<td><strong>Social environment</strong></td>
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<td>Modelling</td>
<td>310</td>
<td>1.14</td>
<td>0.65</td>
<td>380</td>
<td>1.04</td>
<td>0.75</td>
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<tr>
<td>Active Parental encour</td>
<td>302</td>
<td>1.17</td>
<td>1.07</td>
<td>376</td>
<td>0.99*</td>
<td>1.14</td>
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<tr>
<td>Parental demand</td>
<td>305</td>
<td>0.23*</td>
<td>1.38</td>
<td>373</td>
<td>-0.14*</td>
<td>1.43</td>
</tr>
<tr>
<td>Parental allowance</td>
<td>296</td>
<td>1.54*</td>
<td>0.74</td>
<td>368</td>
<td>1.38*</td>
<td>0.94</td>
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<td>Parental facilitation</td>
<td>304</td>
<td>0.21*</td>
<td>1.49</td>
<td>374</td>
<td>-0.11*</td>
<td>1.51</td>
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<tr>
<td>Bring fruit to school</td>
<td>308</td>
<td>-1.16</td>
<td>1.11</td>
<td>379</td>
<td>-1.21</td>
<td>1.11</td>
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<td><strong>Physical environment</strong></td>
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<tr>
<td>Availability at home</td>
<td>309</td>
<td>1.54*</td>
<td>0.53</td>
<td>377</td>
<td>1.40*</td>
<td>0.69</td>
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<td>Availability at school</td>
<td>306</td>
<td>-0.35*</td>
<td>1.73</td>
<td>377</td>
<td>-0.05*</td>
<td>1.75</td>
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<tr>
<td>Availability at friends' house</td>
<td>305</td>
<td>0.60</td>
<td>1.53</td>
<td>373</td>
<td>0.62</td>
<td>1.53</td>
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<tr>
<td>Availability at leisure</td>
<td>229</td>
<td>0.20*</td>
<td>1.67</td>
<td>274</td>
<td>-0.19*</td>
<td>1.62</td>
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<tr>
<td>Fruit intake (Frequency)</td>
<td>310</td>
<td>4.21*</td>
<td>1.73</td>
<td>380</td>
<td>3.91*</td>
<td>1.79</td>
</tr>
</tbody>
</table>

* P<0.05 between intervention and control groups.
Table 3. Mean scores and SD on the determinants and intake for vegetables at baseline and their change between baseline and follow-up, by intervention arm

<table>
<thead>
<tr>
<th></th>
<th>Intervention</th>
<th>Baseline</th>
<th>Control</th>
<th>Change</th>
<th>Intervention</th>
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<td>SD</td>
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<td>SD</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>305</td>
<td>0.37</td>
<td>0.48</td>
<td>373</td>
<td>0.34</td>
<td>0.47</td>
</tr>
<tr>
<td>Attitudes</td>
<td>301</td>
<td>1.37</td>
<td>1.03</td>
<td>376</td>
<td>1.31</td>
<td>1.00</td>
</tr>
<tr>
<td>Liking</td>
<td>299</td>
<td>0.64</td>
<td>1.26</td>
<td>376</td>
<td>0.72</td>
<td>1.19</td>
</tr>
<tr>
<td>General self-efficacy</td>
<td>303</td>
<td>0.73</td>
<td>1.05</td>
<td>375</td>
<td>0.72</td>
<td>1.02</td>
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<tr>
<td>Intention</td>
<td>302</td>
<td>0.58</td>
<td>1.43</td>
<td>376</td>
<td>0.55</td>
<td>1.35</td>
</tr>
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* P<0.05 between intervention and control groups.
There was a positive and significant change on knowledge, active parental encouragement and to bring vegetables to school in the intervention group. The change in availability at school was negative in the intervention compared with the control group. No differences in the frequency of intake both at baseline and change from baseline to follow-up were found between intervention and control groups.

In what concerns correlations’ results, all variables were significantly correlated to children’s change on the frequency of intake of fruit, with the exception of parental allowance, parental facilitation, availability at school, at leisure and at friends’ house (Table 4).

On the other hand, to bring vegetables to school and availability at school were not significantly correlated to children’s evolution of vegetable intake (Table 5).

The results of the hierarchical multiple regression for fruit are shown in Table 6 and for vegetables in Table 7.

**Fruit:** The regression model explained 40.7 % of the variance in children’s fruit intake. Schoolchildren with a greater change in the frequency of intake were those who had lower fruit intake at baseline, perceived fewer barriers both at baseline and in terms of change, reported a strong habit for fruit consumption at baseline and at the end of the study and had a greater change on knowledge about the recommendations for fruit intake.

**Vegetables:** The model explained 47.2 % of the variance in children’s vegetable intake. Children that presented, at baseline, a lower vegetable intake, more negative attitudes towards vegetables, stronger intention to eat vegetables, higher scores on liking and stronger allowance from their parents to eat vegetables, were those with a higher change in the frequency of vegetable intake between the beginning and the end of the study. These children presented higher changes between baseline and follow-up measures in knowledge of the recommendations, habit for vegetable consumption and perceived availability of vegetables at home.
|          | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | 11    | 12    | 13    | 14    | 15    | 16    | 17    | 18    | 19    |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Fruit intake (frequency) | 1     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Knowledge | 0.116** | 1     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Attitudes | 0.092*  | 0.091  | 1     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Liking    | 0.225** | -0.007 | 0.313** | 1     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Self-efficacy | 0.137** | 0.041  | 0.185** | 0.182** | 1     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Intention | 0.236** | 0.089  | 0.219** | 0.424** | 0.224** | 1     |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Habit     | 0.329** | 0.034  | 0.182** | 0.428** | 0.253** | 0.483** | 1     |       |       |       |       |       |       |       |       |       |       |       |       |
| Preferences| 0.124** | 0.070  | 0.126** | 0.169** | 0.058  | 0.167** | 0.149** | 1     |       |       |       |       |       |       |       |       |       |       |       |
| Perceived barriers | -0.124** | -0.041 | -0.155** | -0.176** | -0.230** | -0.192** | -0.135** | -0.112** | 1     |       |       |       |       |       |       |       |       |       |       |
| Modelling | 0.149** | -0.031 | 0.104** | 0.254** | 0.115** | 0.294** | 0.328** | 0.180** | -0.088* | 1     |       |       |       |       |       |       |       |       |       |
| Active Parental encouragement | 0.188** | 0.067  | 0.145** | 0.161** | 0.143** | 0.239** | 0.240** | 0.149** | -0.082* | 0.322** | 1     |       |       |       |       |       |       |       |       |
| Parental demand | 0.124** | 0.074  | 0.089  | 0.046  | 0.044  | 0.182** | 0.167** | 0.141** | -0.041  | 0.131** | 0.279** | 1     |       |       |       |       |       |       |       |
| Parental allowance | 0.045  | 0.062  | -0.000 | -0.002 | 0.001  | 0.104** | 0.064  | 0.013  | -0.052  | 0.128** | 0.062  | 0.067  | 1     |       |       |       |       |       |       |
| Parental facilitation | -0.016 | 0.061  | 0.036  | -0.010 | -0.067 | -0.010 | 0.061  | -0.002 | 0.059  | 0.049  | 0.086* | 0.088* | 0.076 | 1     |       |       |       |       |       |
| Bring to school | 0.119** | 0.093* | 0.045  | 0.051  | 0.049  | 0.077  | 0.105** | 0.117** | 0.057  | 0.134  | 0.063  | 0.090* | 0.076  | 0.129** | 1     |       |       |       |
| Availability at home | 0.135** | 0.101** | -0.025 | 0.083* | 0.115  | 0.109** | 0.160** | 0.129** | -0.085  | 0.137** | 0.133** | 0.117** | 0.291** | 0.094  | 0.094* | 1     |       |       |
| Availability at school | 0.018  | -0.011 | 0.058  | 0.026  | 0.005  | 0.104** | 0.071  | 0.089* | 0.011  | 0.090* | 0.100  | 0.071  | 0.109** | 0.136** | 0.122** | 0.105** | 1     |       |
| Availability at friends' house | 0.028  | 0.113** | 0.009* | 0.100* | 0.095* | 0.140** | 0.158** | 0.085* | -0.094* | 0.110** | 0.096* | 0.113** | 0.066  | 0.072  | 0.140  | 0.170** | 0.170** | 1     |
| Availability at leisure | 0.064  | 0.005  | -0.032 | 0.076  | -0.013 | 0.113* | 0.079  | 0.098* | -0.037  | 0.130** | 0.138** | 0.078  | 0.083  | 0.031  | 0.103  | 0.156** | 0.209** | 0.146** | 1     |

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
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*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
### Table 6. Hierarchical multiple regression for fruit

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<td>0.082</td>
<td>0.088</td>
<td></td>
</tr>
<tr>
<td>Knowledge (Change)</td>
<td>0.100</td>
<td>0.032</td>
<td></td>
</tr>
<tr>
<td>Habit (Change)</td>
<td>0.299</td>
<td>$&lt;0.001$</td>
<td></td>
</tr>
<tr>
<td>Perceived barriers (Change)</td>
<td>-0.180</td>
<td>0.001</td>
<td></td>
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</tbody>
</table>

### Table 7. Hierarchical multiple regression for vegetables

<table>
<thead>
<tr>
<th></th>
<th>1&lt;sup&gt;st&lt;/sup&gt; Block</th>
<th>3&lt;sup&gt;rd&lt;/sup&gt; Block</th>
<th>5&lt;sup&gt;th&lt;/sup&gt; Block</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>STEP 1</td>
<td>STEP 15</td>
<td>STEP 30</td>
</tr>
<tr>
<td>Model adjusted $R^2$</td>
<td>0.336</td>
<td>0.396</td>
<td>0.472</td>
</tr>
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<td>1&lt;sup&gt;st&lt;/sup&gt; Block - Socio demographics</td>
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<td></td>
<td></td>
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<tr>
<td>Sex (male)</td>
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<td>-0.076</td>
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<tr>
<td>Age</td>
<td>0.051</td>
<td>0.084</td>
<td>0.069</td>
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<tr>
<td>Group (intervention)</td>
<td>-0.022</td>
<td>-0.018</td>
<td>-0.064</td>
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<tr>
<td>Vegetable intake (Baseline)</td>
<td>-0.603</td>
<td>-0.666</td>
<td>-0.642</td>
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<tr>
<td>Parental Educational level</td>
<td>0.077</td>
<td>0.089</td>
<td>0.086</td>
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<tr>
<td>Attitudes (Baseline)</td>
<td>-0.234</td>
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<tr>
<td>Intention (Baseline)</td>
<td>0.126</td>
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<td>0.142</td>
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<td>Parental allowance (Baseline)</td>
<td>0.161</td>
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<tr>
<td>Parental facilitation (Baseline)</td>
<td>-0.101</td>
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<td>-0.067</td>
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<tr>
<td>Liking (Baseline)</td>
<td>0.173</td>
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<td>0.192</td>
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<td>Remaining after 5&lt;sup&gt;th&lt;/sup&gt; Block</td>
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<td>Habit (Change)</td>
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<tr>
<td>Availability at home (Change)</td>
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<tr>
<td>Knowledge (Change)</td>
<td>0.163</td>
<td>$&lt;0.001$</td>
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<tr>
<td>Availability at school (Change)</td>
<td>0.085</td>
<td>0.062</td>
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</tr>
</tbody>
</table>
Discussion

This study is of particular interest since it reflects the changes in intake and in the distinct determinants of fruit and of vegetable consumption during one school year, after the delivery of an intervention. At the same time, it sheds some light on the natural evolution of fruit and vegetable consumption in schoolchildren crossing a critical period, since many of them are moving from childhood to adolescence. It is known that the transition from childhood to adolescence is often associated with unhealthy dietary changes, which reinforces the importance of tracking and monitoring children in this critical life stage\textsuperscript{21}.

Our results show that children from the intervention group had a significant higher change in some major determinants of fruit consumption when compared to the control group. This was the case for knowledge, preferences, to bring fruit to school and availability at home, indicating positive effects of the intervention program. However, the result for liking fruit seems contradictory: the intervention group had a significant negative change in this determinant compared with the control group. Children from the intervention had the opportunity to know, contact and taste a wide variety of fruits. This experience may lead to newly acquired food likes, alter innate likes or maintain innate likes that would otherwise disappear\textsuperscript{22,23}. One possible explanation is that this additional experience made children realize that more choices were possible as some of the new experiences were not enjoyed, thus leading to worst evaluation on the liking scale. Another possible explanation to this result is based on Pliner and colleagues’ study\textsuperscript{24} that showed the importance of repeated exposures to enhance the liking of a particular food according to participants’ initial levels of familiarity with that food. That is, while repeated exposure to unfamiliar foods increases liking, (over)exposure to foods that are already familiar may lead to dislike. Given that the taste sessions conducted during Pro Greens intervention included some common fruits and vegetables, this repeated exposure to somewhat familiar foods may had lead participants to rate their liking with lower scores.

Most of the variables studied were correlated to the schoolchildren’s fruit and vegetable intake. However, because of the inter-correlation between independent variables, many of them had a small contribution in explaining the variance of intake in
the multiple regression analysis. This is a problem difficult to solve since variables related to the same behaviour naturally correlate to one another.

In the regression analysis 40.7 % and 47.2 % of the variance in children's fruit intake and vegetable intake, respectively, was explained by the model. The background variables of sex and parental educational level were included in the model as these variables can act like confounders\(^{(25)}\). Neither of them contributed to the explanation of fruit or vegetable intake.

The predictiveness of our model is considered to be good when compared to similar studies. In an Icelandic study among 11-year-old schoolchildren the measured factors explained 31 % and 39 % of fruit and vegetable intake, respectively\(^{(26)}\). In another study with 11-year-old Belgian-Flemish and Dutch Schoolchildren the percentage of explained variance was 33.7 % for fruit and 28.4 % for vegetable intake\(^{(27)}\), whereas a study with Norwegian schoolchildren reported an overall 34 % of explained variance for fruit and vegetable consumption\(^{(28)}\). It is also noteworthy that in our study we included the change on the scores of potential determinants, whereas other authors only used the baseline scores, which may have contributed to improve the predictive power of our model.

Group (intervention or control) didn’t significantly contribute to the explanation of the variance nor in fruit nor in vegetable intake. This may be explained by two major reasons: the period of intervention wasn’t long enough to allow considerable differences and the fact that both children from the intervention and control groups had already a background of nutrition education. Nutrition is part of the official curriculum in Portugal, although integrated in other subjects and activities rather than taught as a separate subject\(^{(29)}\), which prevented us from having children, even in the control group, without any knowledge on healthy food habits, thus reducing possible differences between the groups.

Our results indicate that the factor that most contributed to explain the variance in the change of intake both for fruit and for vegetables was the baseline intake. Children who had lower baseline intake were those who showed greater change of intake. This might indicate that interventions aiming to promote fruit and vegetable intake should particularly address children whose fruit and vegetable consumption is lower.
Our study showed that fruit and vegetable consumption are different behaviours that are influenced by different factors. As proposed by other authors\textsuperscript{(30,31)}, these results support the theory that these food groups should be targeted separately in health promotion programmes.

Habit, measured at baseline, was the strongest personal determinant of change in fruit intake but didn’t have such a great effect in the change of vegetable intake. This indicates that habit plays a somewhat different role for these two behaviors, as also shown by other authors\textsuperscript{(32)}. In fact, fruit consumption has more potential to become usual, a routine, once it is made more voluntarily than vegetable consumption.

Of particular interest is the finding that the change on habit contributed to explain the variance in the frequency of intake of vegetables. This may indicate that the studied children acquired some healthful routines during the intervention and started to eat vegetables as a routine. It might also indicate an increased knowledge derived from the lessons on nutrition that are integrated in the school curriculum.

In agreement with a recent review from McClain et al.\textsuperscript{(33)}, the change on knowledge was positively associated with fruit and vegetable intake. Increasing nutritional education, including skills necessary for preparing fruit and vegetables for consumption and the simple strategy of teaching the recommendations for fruit and vegetable intake, might increase the likelihood of daily intake of these foods and thus contribute to the effectiveness of intervention programs.

For fruit, perceived barriers, both at baseline and change, explained the variance of intake. The fewer the children perceived barriers for fruit intake, the more they consumed it. These results are in agreement with previous findings: in a school-based intervention with over 3800 7\textsuperscript{th} graders, Lytle and colleagues reported that greater perceived barriers implied lower fruit and vegetable consumption\textsuperscript{(34)}. A qualitative research using focus groups conducted among alternative high school students also found that perceived barriers, especially barriers related to access was a hindrance to regular fruit/vegetable consumption\textsuperscript{(35)}. However, a review from Rasmussen et al.\textsuperscript{(14)} states that only one of three studies found a positive association between less perceived barriers and higher frequency of intake and a review by MacClain et al.\textsuperscript{(33)} found no consistent associations. In our study, perceived barriers for fruit consumption were assessed with five questions with a five point-scale from “fully agree” to “fully
disagree”, differently from the other studies where no associations were found. In fact, another study based the Pro Children, using the same methodology of assessment that we’ve used, found similar results\(^{27}\).

It is known that positive attitudes towards fruit and vegetables have a positive association with intake\(^{36-38}\). Our findings indicate that children with negative attitudes towards vegetables at the beginning of the project, but with more positive intention to eat them, were those with the most favourable change in vegetable intake, indicating that a shift in attitudes may be of special importance to increase vegetable consumption and consequently, interventions should address this particular determinant.

Children’s liking vegetables has been shown, by other authors, to be one of the most significant predictor of their intake\(^{36,39}\). In our study, liking vegetables at baseline explained a higher proportion of the variance in vegetable intake. Woodward *et al.*\(^{40}\) showed that schoolchildren’s liking a particular fruit or vegetable was also more strongly associated with the intake of that type.

Repeated exposure to many different kinds of vegetables might therefore be a good strategy to improve liking\(^{41}\).

Regarding social and physical environmental factors, the results from the present study indicate that these may play a more important role on vegetable intake rather than on fruit intake. These findings are different from previous studies, which indicate that, for instance, perceived modelling was a strong predictor of intake both for fruit and for vegetables\(^{28,36,42}\). As previously mentioned, many of the children from our sample were growing from childhood to adolescence. In this transition period, family influences often decrease due to competing influences from other social settings. In our study we found that children whose parents were more permissive in what concerns vegetable intake were those with higher evolution of intake. This result seems to have two pathways to be interpreted. On one hand, children with higher parental allowance feel more free and confident to control their consumption and eat how much they want, thus leading to an increased vegetable intake. In fact, this is partly supported by previous findings that indicate that parental control can be counter-productive\(^{43, 44}\). On the other hand, children whose parents are more permissive, somehow more neglectful and indulgent towards their food habits, may be
more interested to change their behaviour and benefit more from an intervention program, since they don’t find that kind of support at home.

In our study home availability appeared to be a significant determinant of daily vegetable intake but not of daily fruit intake. This is in line with the findings from another European study[36], but somewhat different from others that reported as well an association between home availability and fruit intake[28,45,46]. However, the measures of availability were quite different between studies thus leading to considerable differences in the strength of this relationship.

In what concerns availability at school, this variable was not related to fruit or vegetable intake in our sample of schoolchildren. This is in line with previous findings[36] and suggests that more research is needed to examine how the school environment might alter children’s fruit and vegetable consumption. An integrated approach is needed in order to measure not only the availability at school itself, but also some related factors such as school policies regarding fruit and vegetables, availability of healthy and unhealthy snacks at school and in close-by shops and the curricula on nutrition education.

There are several limitations in our study. First, insight into the predictive relationships between determinants and fruit and vegetable consumption can only be achieved through longitudinal determinant research. Second, Portuguese data derives from a convenience sample, that is not representative of the population. Third, the evaluation has been conducted immediately after the intervention, while it is known to be essential to have measures of at least 6 months after the intervention to be able to study the retention of behavior changes[47]. Additionally the low level of knowledge about the recommended intakes may lead to overestimation of intake. It would also be important to have information on parental consumption of fruit and vegetables, as it is known that parental intake can be an important correlate of fruit and vegetable intake[27,32,46].

Strengths of the study include the use of standardized and validated instrument to measure fruit and vegetable intake and potential personal, social and physical environmental determinants. Furthermore, we’ve used a novel approach in the study of the determinants, by including data from baseline and follow-up periods, allowing
the comparison of the impact of the same variable in two distinct periods. Although our sample was convenient, it had a large size and a high participation rate.

Conclusion

The present results have practical implications for the promotion of fruit and vegetable consumption by children. First, it is extremely important to acknowledge that the consumption of fruit and the consumption of vegetables are different behaviours and therefore, different strategies and approaches must be taken to accomplish better results, namely on what concerns parenting styles and home availability. Second, considering that baseline intake of fruit and vegetables has a crucial role in fruit and vegetable consumption, we must be aware that children with lower baseline intakes will have greater advantages with an intervention program. Third, having into account that habit plays an important role for the consumption of these foods, interventions can be made more effective using strategies to make this behaviour habitual. Finally, more longitudinal studies are needed to determine whether these relationships are causal or not.

Acknowledgments

Authorship: B.P. administered the intervention, analysed the data and drafted the manuscript. B.M.O. analysed the data both at baseline and follow-up and commented the draft of the manuscript. R.P. did the management of the database and worked on the data. B.F. supervised and collaborated in the intervention, helped in literature review and commented on the draft of the manuscript. M.D.V.A. coordinated Pro Greens in Portugal and was the supervisor of B.P. They worked together in writing the manuscript. All authors have participated in the review process and approved the complete manuscript. Sources of funding: The Pro Greens project has been possible by means of a financial contribution from the Programme of Community Action in the Field of Public Health 2003-2008 from the European Commission.
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References


I like what I know: fruit and vegetable preferences and intake in Portuguese schoolchildren

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[Submitted for publication]

Abstract

Objective: To investigate fruit and vegetable preference patterns and associations with intake among schoolchildren.

Design: Data were analyzed from a baseline survey performed with a convenience sample of 6th graders.

Setting: 5 primary schools in Portugal.

Participants: 577 children.

Main outcome measures: Preferences, intake and potential determinants of fruit and vegetable intake were measured.

Analysis: Principal component analysis was used to examine the preferences’ structure of 24 fruits and vegetables. Spearman correlations between the identified patterns and determinants of fruit and vegetable intake were computed. A p-value<.05 was considered to be significant.

Results: Scores on determinants were generally higher for fruit than for vegetables. Two patterns emerged: “High fruit and vegetable preferences” and “High fruit and low vegetable preferences”. The first pattern was associated with higher intake of fruit and vegetables and positively correlated with intention to eat vegetables, liking for vegetables and habit to eat vegetables. In the second pattern there was a negative association with the frequency of intake of vegetables and also with some of the determinants of vegetable intake.
Conclusions and Implications: Taking into account the nature of the factors influencing fruit and vegetable consumption, different approaches to promote its intake are needed.

Keywords: fruit; vegetables; food preferences; child; school

Introduction

Food preferences can be defined as a combination of genetic and environmental factors: whilst genetic factors influence food likes and dislikes and taste perception\textsuperscript{1-3}, children also develop their preferences when exposed to food items, with different tastes, flavours and textures.\textsuperscript{3,4} Although children tend to be neophobic and to reject new foods, repeated exposures generally increase liking.\textsuperscript{4,5} In some cases more than ten exposures to a food are needed before clear changes are achieved.\textsuperscript{4,6} Besides the effects of exposure, behavioural research suggests that social factors from family, peers and social groups strongly influence food selection and development of preferences.\textsuperscript{3,7}

There is a great amount of evidence that certain taste preferences are innate, such as liking for sweet and salt, as well as dislike for bitter and sour.\textsuperscript{4,8,9} However, these preferences are enhanced by increased exposure and tend to decrease by adulthood.\textsuperscript{10} Several studies have investigated the potential determinants of fruit and vegetable (FV) intake in children and adolescents; a considerable array of determinants emerged, among which preferences were consistently found to be an important predictor of FV intake in children.\textsuperscript{11-15}

Taking into account that most European children and adolescents do not meet the recommended intakes for fruit and vegetable consumption\textsuperscript{16-18} and that preferences and dietary habits at these stages of life may track, to a certain extent, into adulthood\textsuperscript{19-21} and possibly trigger some diseases\textsuperscript{22,23}, it is important to understand preferences and the way they interact with other factors related to FV intake in children.
The purpose of the present study was to investigate FV preference patterns among Portuguese schoolchildren and the way these patterns are associated with FV intake and its potential determinants.

Methods

Study design
The present study focus on the Portuguese sub-sample of the Pro Greens (www.progreens.org), conducted in 2009 in ten European countries. Schools nearby the research Centre were recruited, through mail or phone call to introduce the project, followed by a visit from the research staff in order to find out their willingness to participate. All five schools contacted accepted to participate voluntarily. A total of 1004 children from 41 classes were eligible to participate. Parents were reached by mail or through the teachers in order to provide written informed consent for their child and for themselves.

Teachers from the participant schools received information on the project, and during one school lesson, they oversaw the completion of the questionnaire by children, in May 2009. Children also received a questionnaire to be filled in by one of their parents. Subsequently, teachers returned the questionnaires to the research centre that in turn proceeded to data entering and cleaning according to the established protocol. Detailed information on this procedure has been described elsewhere.²⁴,²⁵

Participants
Recruited children were mostly born in 1998 and were 11-year-old in 2009.

A total of 690 children and 618 parents provided questionnaires (response rates of 68.7% and 61.6%, respectively). Parent and child data were matched with a common ID number given to each parent–child set of questionnaires, and information on the child’s gender, birth month and parents’ occupation was used to verify the coupling. Of the 690 children included in the study, 113 observations were eliminated from the analysis due to incomplete data. These children represented 16.4% of the initial sample and did not differ from the others on age, sex or parental educational level.
The study had been previously approved by the Portuguese Ministry of Education in the autumn of 2008. The Scientific Committee of the Faculty of Nutrition and Food Sciences has reviewed and approved the study protocol and decided that it was exempt from Institutional Review Board review. The study was carried out in accordance with the universal ethical principles.  

Measures

Children’s questionnaire comprised three major sections. The first section included an assessment of FV intake with the Food Frequency Questionnaire (FFQ) from the Pro Children study.24,25 All the frequencies in the FFQ were converted in the number of times per day for analytical purposes. Mean total frequency of vegetable intake per day was then calculated by the sum of the frequencies of intake of salad or grated vegetables, other raw vegetables and cooked vegetables. More information on the development and accuracy of the FFQ to rank children’s FV intake can be found elsewhere.27

The second section was designed to obtain information, separately, on potential determinants of FV consumption. Constructs from different behavioural theories were included, to ensure the inclusion of determinants at personal, socio-environmental, and physical-environmental level.28 All constructs, except knowledge and preferences, were assessed with a five-point scale from: ‘fully disagree / never’ (-2) to ‘fully agree / yes, always’ (+2). To assess the knowledge about the recommended intake levels, children were asked on an eight-point scale, with response options ranging from ‘no fruit or vegetables’ (0) to ‘5 pieces or portions per day or more’ (7). Preferences were measured for 12 different fruits and 12 types of vegetables, using 5 response categories from ‘I like very much’ to ‘I dislike very much’ and ‘have not tried’.

The reliability and validity of the constructs to measure these determinants were assessed in a population of children from 5 of the Pro Children countries, including Portugal. The test-retest reliability was good to very good and comparable across countries. Cronbach’s alpha values were moderate to high (range 0.52 to 0.89) with the exception of the self-efficacy scale, which had a value below 0.50 for both fruit (α=0.42) and vegetables (α =0.49).29
The third section contained questions concerning TV viewing, use of computer, gaming consoles and exercise. TV viewing and the use of the computer were assessed with two questions: ‘About how many hours a day do you usually watch television and videos / spend in front of the computer (emailing, surfing, chatting, playing games) and / or playing video games in your leisure time on weekdays / on weekends?’ Response options ranged from ‘none at all’ to ‘about 7 hours a day or more’. Question on physical activity was taken from the Health Education Authority survey\textsuperscript{30}, based on recommended levels of physical activity for this age group.

An English version of the questionnaire is available online at http://www.progreens.org.

Parental educational level was assessed by a questionnaire completed by one of the parents. Children’s sex and age were also included in the analysis. These data were reported by children in the questionnaire.

Data analysis

Descriptive statistics were used. To compute scales, more than 50\% of the scale items had to be answered. As some children didn’t answer some of the questions, there is a slight variation in the number of children included in the analyses.

Factor extraction was carried out using principal component analysis. Preference scores for children who reported an untried item were replaced with the mean of the others individuals’ non missing responses. The number of components was selected by analysis of the scree plot.\textsuperscript{31}

An independent-samples t-test was conducted to examine sex differences in the extracted components.

The relationship between each component and other variables was investigated using Pearson’s correlation coefficient when both variables followed a normal distribution and Spearman’s correlation coefficient (otherwise).

Analyses were conducted using IBM SPSS Statistics 20.00. Missing values were excluded listwise. A p-value < .05 was considered to be significant.
Results

Table 1 describes key participant characteristics: mean age in the study sample was 11.2 years (SD 0.59) and 50.1% were boys. Children spent more time watching TV or using the computer during weekdays and weekends than exercising. 54.8% ($n = 287$) of the parents had a low education level (below 7 years of education) and 11.6% ($n = 61$) have completed higher education.

<table>
<thead>
<tr>
<th>Table 1. Demographic and other characteristics of the study sample</th>
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<tr>
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<tr>
<td>n (%)</td>
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<tr>
<td>Male</td>
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<td>Hours of TV per day on weekdays</td>
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<td>Hours of TV per day on weekends</td>
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<td>Hours of Computer per day on weekdays</td>
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<tr>
<td>Hours of Computer per day on weekends</td>
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<tr>
<td>Hours of exercise per day in leisure times</td>
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</table>

Total mean frequency of intake for fruit was lower than for vegetables and scores on determinants of intake were generally higher for fruit than for vegetables (Table 2). Figure 1 presents children’s preferences for fruit and vegetables. As it can be seen, fruits were more preferred than vegetables. Most preferred fruits were strawberries, cherries and apples, while the most preferred vegetables were ‘salad’, carrots and green peas. Nearly 20% of the children reported that they had never tasted some vegetables namely, leek, spinach and cauliflower.
Table 2. Mean scores of intake and determinants for fruit and vegetables

<table>
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<tr>
<td></td>
<td>n</td>
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<td>SD</td>
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<td>573</td>
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<td>(times per day)</td>
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<td>0.61</td>
<td>574</td>
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<tr>
<td>Perceived availability at school</td>
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<td>-0.2</td>
<td>1.74</td>
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</tr>
</tbody>
</table>

SD, standard deviation.
Scale for determinants ranges from -2 ('fully disagree / never') to +2 ('fully agree/ yes, always') except for knowledge: 0 ('no fruit or vegetables') to 7 ('5 pieces or portions per day or more').
Figure 1. Children’s preferences for 12 fruits and 12 vegetables

- Tomato
- Spinach
- Salad
- Onion
- Leek
- Green peas
- Green beans
- Cucumber
- Cauliflower
- Carrot
- Cabbage
- Broccoli
- Tangerine
- Strawberries
- Plum
- Pear
- Peach
- Orange
- Melon
- Kiwi
- Grapes
- Cherries
- Banana
- Apple

Legend:
- Black: like very much
- Dark grey: like a bit
- Light grey: dislike a bit
- Lightest grey: dislike very much
- White: have not tried
Preference patterns

Two main preference patterns were identified (Table 3): a) ‘High FV preferences’, characterized by high preferences for both fruit and vegetables, especially for all vegetables, plums and oranges; b) ‘High fruit (F) and low vegetable (V) preferences’, positively correlated to fruits and negatively correlated with vegetable preferences (except for green peas and tomatoes).

The explained variance for these two factors was 27.1% and 11.0%, respectively.

Table 3. Factor structure of fruit and vegetable preferences in the study sample (n = 577)

<table>
<thead>
<tr>
<th>Preferences items</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Communalities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High FV preferences</td>
<td>High F and low V preferences</td>
<td></td>
</tr>
<tr>
<td>Apple</td>
<td>0.222</td>
<td>0.120</td>
<td>0.387</td>
</tr>
<tr>
<td>Banana</td>
<td>0.317</td>
<td>0.037</td>
<td>0.492</td>
</tr>
<tr>
<td>Pear</td>
<td>0.317</td>
<td>0.074</td>
<td>0.464</td>
</tr>
<tr>
<td>Orange</td>
<td>0.450</td>
<td>0.396</td>
<td>0.750</td>
</tr>
<tr>
<td>Tangerine</td>
<td>0.403</td>
<td>0.497</td>
<td>0.714</td>
</tr>
<tr>
<td>Plum</td>
<td>0.434</td>
<td>0.527</td>
<td>0.537</td>
</tr>
<tr>
<td>Peach</td>
<td>0.425</td>
<td>0.461</td>
<td>0.537</td>
</tr>
<tr>
<td>Melon</td>
<td>0.418</td>
<td>0.157</td>
<td>0.437</td>
</tr>
<tr>
<td>Strawberries</td>
<td>0.391</td>
<td>0.488</td>
<td>0.454</td>
</tr>
<tr>
<td>Grapes</td>
<td>0.427</td>
<td>0.499</td>
<td>0.456</td>
</tr>
<tr>
<td>Cherries</td>
<td>0.427</td>
<td>0.537</td>
<td>0.559</td>
</tr>
<tr>
<td>Kiwi</td>
<td>0.432</td>
<td>0.345</td>
<td>0.344</td>
</tr>
<tr>
<td>Green peas</td>
<td>0.531</td>
<td>0.010</td>
<td>0.603</td>
</tr>
<tr>
<td>Tomatos</td>
<td>0.533</td>
<td>0.028</td>
<td>0.497</td>
</tr>
<tr>
<td>Cucumber</td>
<td>0.558</td>
<td>-0.043</td>
<td>0.579</td>
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<td>Salad</td>
<td>0.659</td>
<td>-0.236</td>
<td>0.520</td>
</tr>
<tr>
<td>Cabbage</td>
<td>0.677</td>
<td>-0.312</td>
<td>0.608</td>
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<tr>
<td>Spinach</td>
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<td>0.639</td>
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<td>Leak</td>
<td>0.684</td>
<td>-0.316</td>
<td>0.593</td>
</tr>
<tr>
<td>Green beans</td>
<td>0.588</td>
<td>-0.207</td>
<td>0.441</td>
</tr>
<tr>
<td>Onion</td>
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<tr>
<td>Carrot</td>
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<td>-0.386</td>
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<td>Broccoli</td>
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<td>0.718</td>
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<tr>
<td>Cauliflower</td>
<td>0.592</td>
<td>-0.189</td>
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KMO measure of sampling adequacy = 0.900
Bartlett's test of sphericity: \( \chi^2 = 4355.134 \) (df = 276; \( p < .001 \))

Spearman correlations between the studied variables with the two identified patterns are presented in Table 4.
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<tr>
<th></th>
<th>Frequency of intake</th>
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<tr>
<td></td>
<td></td>
<td>n</td>
<td>ρ</td>
<td>p</td>
<td>ρ</td>
<td>p</td>
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<tr>
<td>Total fruit intake (times per day)</td>
<td>577</td>
<td>0.31</td>
<td>&lt;.01</td>
<td></td>
<td>0.08</td>
<td>.07</td>
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<tr>
<td>Total vegetable intake (times per day)</td>
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<td>0.28</td>
<td>&lt;.01</td>
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<tr>
<td>Self rated intake</td>
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<td>.00</td>
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<td>.95</td>
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<td>Attitudes</td>
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<td></td>
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<tr>
<td>Bring vegetables to school</td>
<td>575</td>
<td>0.18</td>
<td>&lt;.01</td>
<td></td>
<td>0.12</td>
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<td>.08</td>
<td></td>
<td>-0.06</td>
<td>.18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
All studied variables were significantly correlated with the ‘High FV preferences’ pattern with the exception of perceived availability of fruit and vegetables at school, parental facilitation (only for fruit) and knowledge on the recommended levels for vegetable intake. Both for fruit and vegetables, preferences showed to have a positive, significant and strong correlation with this pattern. We found weak, although significant, negative correlations for perceived barriers for fruit and vegetable consumption. The remaining variables had weak to moderate positive and significant correlations with this pattern, according to Cohen’s criterion.32

The pattern ‘High F and low V preferences’ was negatively and significantly correlated with vegetable intake and most of its potential determinants. On the other hand, practically no associations between this pattern, fruit intake and its determinants were found. Preferences for fruit showed to have a moderate positive correlation, while preferences for vegetables had a moderate negative correlation with this pattern.

There were no differences between sexes in these scores, neither for the ‘High FV preferences’ pattern ($t(575) = 0.38, P = .70$) nor for ‘High F and low V preferences’ ($t(575) = 0.69, P = .49$).

There was a weak, positive correlation between age and ‘High FV preferences’ ($r = 0.09, P = .04$). For ‘High F and low V preferences’ we found no significant correlation with age ($r = -0.02, P = .63$).

Weak correlations between preference patterns and leisure and physical activity times were found. Parent educational level was not significantly correlated with the two identified patterns.

**Discussion**

To our knowledge this is the first study that identifies patterns of FV preferences and their relationship with behaviours related to FV consumption among Portuguese schoolchildren. From all the psychosocial determinants of FV consumption in children, preferences are one of the best supported by the literature.11-15

In agreement with previous studies18, overall frequency of consumption of FV reported by this group of schoolchildren was low.
As reported earlier\textsuperscript{33-36}, our results suggest that children are more likely to prefer fruits as compared to vegetables. This might be explained by a preference for sweet flavoured foods.\textsuperscript{4,9} Research has provided some evidence for a biochemical basis for some dislikes, with sensitivity to the bitter taste of 6-n-propylthiouracil being indicative of lower liking for bitter foods.\textsuperscript{37} Among vegetables, our results corroborate that children prefer the sweeter ones\textsuperscript{38}: ‘salad’, carrots and green peas were the most preferred ones, whereas strong tasting, bitter \textit{Brassica} vegetables (e.g. broccoli and cauliflower) and \textit{Allium} vegetables (e.g. onion and leek) were the least preferred. Thus, it seems important to reinforce strategies, like flavour-flavour learning, flavour-environment learning and flavour-nutrient learning, which might help to achieve a shift in children’s preferences for vegetables. Even mere exposure can constitute an effective strategy to improve preferences: Wardle et al.\textsuperscript{39} found that exposing children who disliked vegetables for 14 days increased liking and consumption of vegetables. The importance of exposure becomes even more evident when we find that many children in our sample had never tried some of the vegetables: nearly 20\% never tried leek, spinach, broccoli or cauliflower. Observational learning or modelling whereby children imitate the eating behaviour of important others, seems also a relevant strategy to increase acceptance. However, these strategies should not be used alone, but rather combined with other activities in a multicomponent setting to maximize its effectiveness.\textsuperscript{40,41}

The preference patterns identified in our study elicit that higher preferences for fruit and / or vegetables are associated with positive scores on potential determinants of FV consumption. In the ‘High FV preferences’ pattern, positive associations for FV frequency of intake were found, whereas in the pattern ‘High F and low V preferences’ pattern a negative association with the frequency of intake of vegetables was found. This is in line with previous research that repeatedly found that preferences were related to likelihood of daily FV intake\textsuperscript{12,33,42-45} and suggests that focusing on interventions designed to increase taste preferences may lead to increased FV intake among children.

In the ‘High FV preferences’ pattern, positive associations were also found for most of personal factors related to FV consumption (namely liking, intention and habit), as well as for social-environmental factors (modelling, family rules and bring fruit / vegetables
to school) and physical factors (perceived availability at home). Liking, intention and habit have been repeatedly linked to higher intake levels of FV.\textsuperscript{14,46} In our study, liking, intention and habit to eat vegetables had correlations between 0.44 to 0.48 with this pattern.

Habit can be defined as a behaviour that has become adopted by repetition or routine. If a habit is well established other psychosocial factors lose importance in the decision-making process, since they are already reflected in the habit.\textsuperscript{46} If children are used to consume FV, it is natural that they will keep that consumption and possibly increase their preferences over time.

On the contrary, in the ‘High F and low V preferences’ pattern, there was a negative association with some personal (e.g., liking, intention and habit), social environmental (e.g., modelling and bring vegetables to school) and physical factors of vegetable consumption. It seems thus that lower preferences for vegetables are linked to negative scores on potential determinants of vegetable consumption; as a consequence, increasing preferences for these food items can help shape consumption and favourably alter its related behaviours.

It is known that FV availability constitutes an important factor influencing a child’s preferences and intake.\textsuperscript{15,47} Availability at home was associated with the two identified preference patterns in our study. In the ‘High FV preferences’ pattern, there was a positive correlation with availability at home, suggesting that children only needed FV in the home to make the effort to consume them. It is known that when FV availability is low, exposure to these foods will be limited, which in turn may lead to a low preference for the taste of fruit and vegetables.\textsuperscript{4,48} These findings also reinforce that parents play an important role in shaping their children’s preferences, namely through improved availability and accessibility of FV at home. Similarly, Neumark-Sztainer et al.\textsuperscript{43} have shown an interaction between availability of FV at home and preferences in predicting adolescents’ intake. Therefore, it seems of extreme importance to enrol parents in this process and encourage them to increase home availability and accessibility (for instance, by washing, cutting and preparing) of fruits and specially vegetables, that are less easily available for consumption. Children may not eat vegetables despite liking them, as lower accessibility can constitute a barrier to intake.
In line with previous research conducted among European children\(^4\), results from the present study shows that children spent many hours watching TV and using the computer. The results were more prominent for weekends, although also high on weekdays. A recent systematic review\(^5\) highlighted the existence of consistent associations between these sedentary behaviours, especially TV viewing, in children and adolescents and unfavourable dietary behaviours, including, among others, lower FV consumption, higher consumption of energy-dense snacks and drinks. Furthermore, it was found that high levels of TV viewing (more than 2 hours per day) were associated with a lower preference for fruit and vegetables.\(^6\) We found significant negative associations between time spent with TV and computer on weekends and the 'High FV preferences' pattern. Thus, if aiming to improve FV preferences in children, screen time should be considered a potential important influencing factor, and restricting this behaviour may be beneficial for the development of healthy food preferences.

Both patterns revealed a high preference for fruit but not for vegetables, clearly indicating that messages to promote FV consumption and preferences in schoolchildren must be separate ones. As advocated by other authors\(^7\), fruit and vegetables should be addressed as separate food groups in interventions for the promotion of these food items.

In drawing conclusions from this study, its strengths and limitations need to be acknowledged.

Strengths of this study include its novelty, exploring patterns of FV preferences. All determinants were measured with several constructs from different behavioural theories, in line with state-of-art health promotion, to ensure the inclusion of potential determinants at personal, social and environmental level.

Some limitations to the current research must be noted. All data were self-reported by children, and thereby are subject to the usual bias associated with their ability to recall intake accurately and to social desirability. The analyses were based on questionnaire variables and a potential risk of misreporting is present; a random bias in the reporting of FV preferences as well as in the other variables would tend to attenuate the true associations and hence, results may have been stronger than those observed.
Implications for research and practice

The different nature of the factors influencing choice and intake of fruit and vegetables calls for different approaches to promote intake of these two food groups. Commonly, people consider that these are in fact two different food groups, whose consumption is shaped by different factors. Scientific evidence does not provide a solid base for its joint promotion and therefore, distinct interventions to promote its consumption should be considered.

Acknowledgments

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The authors would like to thank the participating children, their parents and the school staff that have worked on the Pro Greens project in Portugal.

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Listen to the participants: adolescents’ views on an intervention to promote fruit and vegetable intake

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[Submitted for publication]

Abstract

Background: This paper focuses on a qualitative evaluation of a school-based intervention, Pro Greens, to promote fruit and vegetable (FV) intake. The objectives were to gather participants’ views on the intervention, to elicit their opinions to guide the development of future programs and to analyze the main determinants of FV consumption.

Methods: Focus groups were carried out in two schools that participated in the intervention. 28 students (12 boys, 16 girls) aged 14 to 16 years-old participated in the sessions. Transcripts were analysed using qualitative research methodology.

Results: Participants acknowledged that Pro Greens had a long time impact in their FV consumption. Taste sessions, activities combining physical activity with healthy eating, theatre plays, use of celebrities, price campaigns and FV schemes were the most frequently suggested activities to include in future interventions. Major factors identified as being determinant for FV consumption were preferences, liking, physical and sensory attributes, habit, availability, accessibility and parental influences.

Conclusions: The determinants of FV intake were sustained in time, from late childhood to adolescence. Easy to implement suggestions were among the outcomes of the study, reinforcing the importance of including students’ views in healthy school program and policy development.

Keywords: Child & Adolescent Health, Evaluation, Public Health, School Health Services
Background

Fruit and vegetable (FV) consumption is constantly being promoted worldwide. Attempts to reach the World Health Organization goal of at least 400 grams of FV consumption per day\textsuperscript{2} have been undertaken among adults, adolescents and children through various types of interventions. Younger groups seem to be the natural target population for these interventions, since the adoption of healthy lifestyles at this stage of life is associated with health and wellbeing in adulthood.\textsuperscript{2} Also, it seems easier to promote eating behaviours at this time, once these are not as firmly rooted as in adults\textsuperscript{3} and the food habits acquired during childhood tend to extend to adolescence and adulthood.\textsuperscript{4,5}

From several reviews\textsuperscript{6-11} to evaluate the effectiveness of school-based interventions to improve FV intake, only three\textsuperscript{6,7,9} included a meta-analysis that enabled the impact of programs to be quantified: the review with possibly higher quality concluded that school-based interventions moderately improved fruit intake but had minimal impact on vegetable intake.\textsuperscript{7}

When designing interventions for FV promotion, it is important to involve participants from the early stages in order to gain insight on the potential determinants of consumption as well as on the activities that should be developed in order to make the intervention effective and attractive. Qualitative research can be very useful, since it brings new knowledge about behaviour determinants and describes the cultural patterns associated with particular settings.\textsuperscript{12,13} Focus group interviews elicit participants' personal perceptions of a defined area of interest through planned and semi-structured discussions and seem to be an excellent vehicle to help gain the young person's perspective on a variety of issues related to health and wellness.\textsuperscript{14}

Focus groups are commonly carried out as part of the stepwise development of an intervention program or to inform alternative approaches to develop future interventions.\textsuperscript{15-20} However, in-depth qualitative research in order to grasp participants' views and opinions are seldom conducted as quantitative methods are regarded as the "gold" standard to assess interventions' outcomes.

The aims of this study were threefold: (i) to identify factors related to participants' FV intake; (ii) to gain insight into participants' views about an intervention program to
promote FV consumption, in what concerns its contents, activities and effect on
behavioural change, three years after the intervention was completed; (iii) to
understand participants' motivations to join these programs and to elicit their views on
the activities considered relevant to be included in order to inform the design of future
interventions.

Methods

Participants
Participants were recruited in the two schools that took part in Pro Greens
intervention. Pro Greens was a theory-based European study in which Portugal was
one of the ten participating countries. This project (August 2008 to July 2011) aimed to
assess FV intake before and after a school-based intervention and to develop effective
strategies to promote FV consumption among 11-year-old schoolchildren. Further
information can be found at www.progreens.org
In Portugal this project was implemented in 5 schools in the North region. Schools
were randomly assigned into the intervention and the control arms of the study.
A multicomponent intervention (school, family and community) was carried out during
approximately one school year. Two measurements were performed during the
project. In both measurements, children were asked to fill in a questionnaire adapted
from the Pro Children study and information on its development, validity and reliability
can be found elsewhere. The final Portuguese sample consisted of 690 11-year-old
schoolchildren, 380 from the control and 310 from the intervention schools.
Three years after the follow-up measurement, the two intervention schools were
invited to participate in focus group sessions. Inclusion criteria for this study were that
the participants had previously participated in the Pro Greens intervention, expectedly
aged 14 to 16 years old. A sub-sample of these students was randomly selected using a
random number generator. A total of 28 students agreed to participate voluntarily and
delivered written informed consent from their parents / guardians.
Instrument

An interview guide with instructions for the interview procedure and a checklist of questions / topics to be discussed was developed. Questions were tailored to suit participants’ age and were pilot-tested on 5 students to ensure they were clear and understandable. The interview guide was based on findings from literature reviews\textsuperscript{23} and original qualitative studies\textsuperscript{19,24-26} which evaluated intervention programs and investigated determinants / motivators and barriers for healthful eating, particularly for FV consumption.

The general questioning route is shown in Table 1. Some of the questions were not actually asked because the theme naturally emerged in the discussion. Different questions were used to address fruit and to address vegetables.

Procedure

All focus group sessions were held at school during school hours. The focus group interviews were conducted by a moderator and a research assistant who took field notes about the interaction, including physical gestures and details about the surroundings throughout discussion and monitored the interview process. Each session lasted between 30 minutes to 49 minutes (M = 39 minutes) and was audio-taped.

Prior to the beginning of each session, participants were asked to provide basic demographic information. Rules of conversation, confidentiality, anonymity issues and recording of the sessions were explained.

6 focus groups were conducted involving students aged 14-16 years old, who were divided into 4-6 participants per group.

We’ve conducted distinct focus group interviews with girls only, boys only, and both boys and girls in order to understand if there were differences in the behaviour during the interviews, once it is known that boys may be quite reluctant to discuss certain topics with same-aged girls; when there is a high interest in the opposite sex, such as happens with adolescents, these combined sex groups may negatively affect group productivity.\textsuperscript{14}

Conducting 6 focus group sessions has been found to be adequate in reaching a point of saturation, i.e., a point after which no more new information was retrieved from the interviews.\textsuperscript{27}
Table 1. General questioning route for the focus group interviews

<table>
<thead>
<tr>
<th>Introduction and icebreaker question</th>
</tr>
</thead>
<tbody>
<tr>
<td>We would like to thank you for being here today. The purpose of this meeting is to better understand your views and feelings about fruit and vegetables and on a program that was implemented at your school some time ago, in which you were enrolled – The Pro Greens. Firstly, we would like to ask the first thing that comes to your mind when you think of fruit and vegetables. Of which do you remember first? What smells, tastes, colours and sensations occurs to you when you think about them?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A. Factors related to FV consumption and choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Usually where do you eat fruit / vegetables (at home, at school ...)? In which meals and with who do you eat fruit / vegetables?</td>
</tr>
<tr>
<td>• Is it usual to have a lot of variety of fruit / vegetables at home? Do your parents or other relatives ask you to eat fruit / vegetables?</td>
</tr>
<tr>
<td>• What do your parents say about fruit / vegetables?</td>
</tr>
<tr>
<td>• Is there anyone that you consider to influence your fruit / vegetables intake?</td>
</tr>
<tr>
<td>• Can you explain what the recommendations for fruit and vegetable intake mean? Does anyone know how many portions / pieces of fruit and vegetables we should eat daily?</td>
</tr>
<tr>
<td>• Do you think you eat adequate amounts of fruit and vegetables?</td>
</tr>
<tr>
<td>• Who eats fruit / vegetables daily?</td>
</tr>
<tr>
<td>• Who eats fruit / vegetables never or hardly ever? Why?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Program Evaluation and Inputs for future programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Do you remember Pro Greens program?</td>
</tr>
<tr>
<td>• What is your overall impression of the program? Did you enjoy participating in the Pro Greens?</td>
</tr>
<tr>
<td>• Did you talk about Pro Greens with your family or friends?</td>
</tr>
<tr>
<td>• Imagine you were going to tell a friend that doesn’t attend your school about the Pro Greens. What would you tell about the program?</td>
</tr>
<tr>
<td>• Regarding the program, what are the things you like? What are the things you dislike?</td>
</tr>
<tr>
<td>• Do you feel that the program changed the amount of fruit and vegetables that you consume now? (free elicitation)</td>
</tr>
<tr>
<td>• What kind of activities do you think that should be included in future programs with identical purposes of the Pro Greens?</td>
</tr>
<tr>
<td>• What could we do to help you eat more fruit and vegetables?</td>
</tr>
</tbody>
</table>
Data Analysis

After the sessions, taped interviews were transcribed verbatim and the field notes were used to ensure comprehensive analysis of the discussions. Significant patterns were grouped according to common themes using the cut and paste technique.²⁸ With this method, the first author identified a coding system for major issues and themes, using different symbols to identify distinct topics within each transcription. The coded transcripts were then cut apart and pasted in order to gather all the information on an identified topic. Topics prioritization was based on the frequency and extent to each topic was discussed during the focus group session. A second researcher independently reviewed analyses for final data interpretation. At the end of the process, a final summary report was prepared and reviewed by the whole research team. As data were qualitative, frequencies are used only in the broadest of terms (e.g., many, some, a few).

Results

12 boys and 16 girls (aged 14-16 years old) attending the 9th grade (according to the Portuguese Education System) participated in the focus groups. All the participants were born and lived in the city of Vila do Conde, an urban area nearby the Porto city. Results are described according to important issues that were derived from the analysis.

Factors influencing FV choices and consumption.

Participants identified 11 factors as influencing their choices and consumption regarding fruit and vegetables. These were categorized into 3 levels according to the frequency and extensiveness which they talked about them, in a descending order. First level factors included preferences, liking, and sensory and physical attributes such as taste, colour, shape, smell / odour and texture. Taste was the most referred sensory attribute by the participants, leading to acceptance or rejection depending on liking / disliking FV taste:
“I don’t eat any raw vegetable because I don’t like the taste. If it’s cooked, then I’ll eat it. Preferably I’ll eat them on the soup, all mashed, because the texture sometimes bothers me.” (Boy, 14 years old)

Level-two factors included habit, food availability and accessibility (especially at home) and parental influences. The most cited meals that included fruit and vegetables were lunch and dinner and were often eaten at home. A few mentioned they used to eat fruit at breakfast and as an afternoon snack.

Parents, particularly mothers, seemed to play an important role in their food choices and FV consumption:

“There’s always soup at home. My mother makes it every day. At lunch and dinner we always eat it at the beginning of the meal, because my parents say that if we eat the soup we’re getting the important stuff ...” (Boy, 15 years old)

The third level included health-related factors such as being good for general health and issues regarding body image and body weight:

“Before swimming it is important to eat banana because it has potassium and does not weigh much in the stomach. “ (Girl, 14 years old)

“Fruit and vegetables prevent us from getting fat.” (Girl, 14 years old)

All participants preferred fruit over vegetables. Fruits most commonly preferred were apple, pear and banana. For vegetables, carrot, lettuce and tomato were the most frequently mentioned. Participants acknowledged that their fruit intake was higher than vegetable intake. Furthermore, the word fruit was mentioned much more times across all the discussions than the word vegetables.

It is noteworthy that soup constituted the major source of vegetable intake among the participants. Many mentioned that they eat soup at lunch and dinner, often with mashed vegetables. Some also indicated that they don’t eat soup at school, because it “tastes terribly”.

Most of the participants were not aware of the recommendations for FV intake. They stated that it is important to eat adequate amounts to reach health and well-being, but they didn’t identify specific benefits. They were unable to quantify how much they should eat, or only had a rough idea of the recommended levels. Consequently, when
asked if they thought to achieve the recommend intake levels, responses were very inconsistent. A few mentioned that we should follow the recommendations established on the Portuguese Food Wheel, referring that it is a guide for healthy eating that has seven food groups. In this case, participants knew that vegetables constituted the second larger group of the food wheel, followed by fruit.

**Participants’ views on the Pro Greens.**

Overall, participants stated that they enjoyed Pro Greens and that the program gave them the opportunity to learn and experience new fruits and vegetables and to rediscover others that they thought they didn’t like. Some of them said that the program helped them to increase their consumption even after the end of the program.

They recalled many of the activities developed during the intervention, especially the taste sessions. Many reported that the use of funny formats to present fruits and vegetables in the taste sessions (for example, the sun-shaped radish) constituted an effective and appealing way to make them want to try these foods:

“I loved the rabbit-shaped cucumber. It was so cute. We made some food drawings on our plate and then ate all the stuff.” (Girl, 14 years old)

Also, many said they liked the FV breaks in the classroom. They said they took fresh fruit and sandwiches made with vegetables to eat together in the presence of their teacher and that this was a way of not being ashamed to take fruit and vegetables to school.

The participants reminded some of the specific materials of the project that were offered during the intervention, namely a lunchbox, a key ring and a book with a set of guided activities, as illustrated by these quotes:

“There was a lunchbox you gave us... It was white and with the Pro Greens logo on it. I used to bring it to school with my snacks. Then my sister got it.” (Girl, 14 years old)

“You gave us a book with activities (...) It had some worksheets to tell if we liked the fruit and vegetables from the taste sessions and also a soup of letters... I remember the cover was red.” (Boy, 15 years old)
A few participants recalled the study tours made to a local supermarket, as well as the nutritional education sessions held by a nutritionist but no one has mentioned the celebration of special occasions (e.g. Christmas) with Pro Greens, nor the Pro Greens’ blog or the FV calendar that was placed in each classroom.

**Participants’ suggestions for the improvement of future programs.**

The most common suggestion that emerged during all discussions was to increase the number of taste sessions, keeping the original formats used in Pro Greens, in future intervention programs:

“*I think it is very important to keep the taste sessions. We should try a food at least seven times in order to know whether we like it or not. It’s important to try and to insist.*” (Boy, 15 years old)

Participants mentioned that activities that stimulate competition are always good and are well accepted by students. They stated that competition could be introduced in several ways, including a mixed approach for FV promotion through physical activity with sports games, traditional games like blind man’s bluff or hopscotch or even in the school canteen:

“We should launch a contest in the canteen and for a time control the intake of fruit, soup and salad and register it on a board (...) At the end of the contest, the one who ate more would win a good prize, a console or a trip, I don’t know... It would be good because even after the end of the contest, we would’ve eaten so many times that we started to enjoy.” (Girl, 14 years old)

The third most common suggestion was to introduce a play / theatre performance with FV costumes or puppets. The purpose would be to introduce the importance of healthy eating in a fun way:

“A play with puppets or involving ourselves and other students with proper costumes would be nice. Actors should interact with the audience and tell them about FV health benefits” (Boy, 14 years old)

Study tours were mentioned by some, but participants could not describe the places that should be visited or the purpose of the visit. Also, some of the participants said that the presence of a public figure, such as an actor / actress, a football player or even
a famous cook or nutritionist would increase students’ attention and could lead to an increase in FV consumption:

“If he is one of our idols, we want to be like him. If he eats vegetables, we will also eat to be like him.” (Girl, 14 years old)

“A famous cook or a nutritionist that shows up on TV showing different ways to cook vegetables and delivering the message about how these foods are good for us would make a difference.” (Girl, 15 years old)

A few mentioned that it would be of interest to offer free of charge or cheaper fruit and vegetables in the school cafeteria and to improve the quality and variety provided in the school canteen. Participants expressed a notorious concern with food waste and with disadvantaged children:

“It would be nice to provide free fruit and vegetables at school or with attractive prices, especially with the economic crisis in our country that is affecting students at our school. But I think that no one should be forced to accept it, because it could increase the waste; many children would throw the fruit away.” (Girl, 14 years old)

One participant also raised some concerns related with the evaluation process of the program:

“We should keep the questionnaires and the book of activities from the Pro Greens to monitor program results.” (Boy, 15 years old)

**Sex comparisons.**

Similar factors were mentioned by boys and girls. However, some differences were noticed in what concerns health-related issues: girls tended to value body-weight issues, while boys referred that a healthy diet that includes fruit and vegetables could help them achieve better sports performance.

The mixed gender groups generated longer discussions than the singular ones, but no different themes emerged.

Finally, across sex, students said that the program should cover the whole school and not just 6th graders as it happened for Pro Greens. To promote FV consumption, some
participants wanted longer intervention programs with more involvement from the teachers.

In a nutshell, the ultimate students’ concern is clearly represented in this statement:

“The program has to be fun and attractive enough so that these foods become trendy and popular at school. Nobody wants to be mocked by eating in a healthy way!”

Discussion

The current study has a number of strengths that must be noted. First, we’ve used a qualitative approach to evaluate the impact of an intervention to promote FV intake. This is an underexplored procedure that allowed putting together participants with common experiences, engaging them to share ideas and perceptions that otherwise would be lost.

We have conducted focus groups approximately three years after the intervention was completed. This was done for several reasons: to understand if there was a considerable shift in the determinants of FV choice and consumption, as the children previously enrolled in the Pro Greens grew to adolescence, a period of particular vulnerability to societal and peer pressure.29 It is known that adolescents tend to express their independence through their eating behaviour, tend to increase control of what, when and whom they eat, and tend to consume more food outside the home. Furthermore, our participants will possibly attend the 10th grade on the next school year in another school, since the intervention schools only provide 9th grade level. So this was the last opportunity to address them in the same setting. Another reason relates to the fact that we needed more information on what they recalled from the project and the way they evaluated it. It is known that nutrition behavioural change interventions such as Pro Greens can only have an impact in health if effects are maintained or even improved over time. By using the this method we were able, to a certain extent, to conduct an assessment of the longer-term impact of the intervention and, at the same time, to get insight on the activities that participants considered to be more relevant, as well as to gather information for future program development.
In what concerns FV consumption and choices, a broad range of factors influenced adolescents. These findings need to be addressed in the design of interventions to promote FV intake if they are to be effective in leading to sustained behavioural change. Previous results from Pro Greens showed that the determinants with higher evolution between the baseline and follow-up measurements in the intervention group were, among others, knowledge, preferences, parental rules and perceived availability at home (unpublished personal data). In the present study, the above mentioned factors were identified by the participants as being influential on their FV choices. This study supplements the quantitative knowledge base adding other factors: sensory and physical attributes, health and body image concerns.

In our study, the sensory experience of FV consumption has shown a consistent relationship with fruit intake while the taste of vegetables seemed to present a major barrier to consumption. In a recent review of qualitative studies about the determinants of FV consumption among children and adolescents, sensory and physical aspects of FV were also identified as potential determinants of intake.

In agreement with previous studies, our participants preferred fruit over vegetables.\textsuperscript{17,19,20,30} Furthermore, participants reported higher fruit consumption reinforcing the idea that preferences are related to the likelihood of daily intake of fruit and vegetables.\textsuperscript{30-33} It is notorious that participants’ reactions towards fruits and vegetables were very distinct. This reinforces the idea that interventions should not address these two food groups together.\textsuperscript{34}

It is important to highlight the importance of soup for vegetable provision. Soup was mentioned as the most common way to eat vegetables, but participants considered that the soup from school canteen had a bad taste and quality. There is a strong tradition associated with soup consumption in Portugal and previous results show that soup largely contributes for vegetable intake in children.\textsuperscript{35} Therefore, it is crucial to improve the overall quality of the soups provided at school as well as to find alternative ways to promote its consumption in the school environment, namely through price campaigns, workshops and cooking lessons.

Also supported by previous findings\textsuperscript{23} it is of particular concern that participants knew so little about the recommended intake levels and the specific health benefits related to FV consumption. This has implications for future intervention design and suggests
the need for clear information about the way to translate knowledge into practice, rather than passing the traditional message of the health benefits.

From our results, it can be concluded that participants recalled a large amount of information about Pro Greens, even after such a long period of time. Overall, participants enjoyed it and indicated a positive change in their previous opinions about fruit and vegetables, mostly conditioned by the taste sessions. Similar evaluations of students’ perceptions of FV programs have also identified that participants enjoyed the opportunity to try new fruits and vegetables.24 The present work further suggests that Pro Greens might contribute to the establishment of positive dietary habits in a longer-term period rather than only immediately after the intervention.

The most mentioned and preferred activities were the taste sessions, followed by the FV breaks during Pro Greens. These activities should be considered in future programs, since they seem to be the most outstanding for the participants.

In what concerns generating ideas to help and guide the development of future interventions, many suggestions emerged. One of the most interesting findings is that they suggested activities in different settings, involving teachers, students, school staff and even parents. They were actually identifying a multicomponent intervention.

Most of the activities that were suggested seemed to be easy to accomplish with a relatively low budget, which leads us to one important debate that is the cost-effectiveness of intervention programs. There is not enough evidence to state if they are cost-effective.36 Our findings lead to inexpensive and useful activities to implement and turn an intervention worth of investment. However, there seems to be a recurring problem with the intervention delivery, that is, how well the intervention will be implemented in the school setting with teachers’ guidance. In fact, the degree of implementation of an intervention has been reported to determine the impact of a program.37,38 A possible solution may involve the permanent inclusion of these activities in the formal curriculum of the schools, which already occurs in many countries.39

Participants considered that it would be important to create a longer program to cross all the school grades. Once again, this issue brings an important discussion about FV interventions: how much time do we need? If intervention programs are to be
effective, that is, to improve the health of the participants, they must run continuously over long periods of time.\footnote{7}

**Limitations**

A methodological limitation is that focus group results can’t be generalized. Our findings are specific to the study population. However, they provide insight on the range of possible determinants of FV and on the activities that should be promoted in future intervention programs, mainly when corroborated by other results in the literature.

Further limitations include the fact that focus group results are also subject to social desirability bias.

**Conclusions**

In summary, the results of our study point that determinants of FV intake were sustained in time, from late childhood to adolescence. The students were keen to explore new ways to increase FV intake and develop a supportive nutritional environment at school. Their collective brainstorming generated numerous activities, easy to implement and that respond to adolescents’ specific needs that must be taken into account by public health decision-makers when tailoring future interventions. Additional strategies to improve liking, preferences, sensory and physical attributes, availability of fruits and vegetables, parental involvement and quality of food provided in the school setting should be adopted.

**Implications for School Health**

This study brings new knowledge to the development of school-based interventions that may benefit the overall school health, namely:

- Shows that student can and should play an active role in decision making about school health programs and act as intervention deliverers. Consequently, greater student involvement would reduce the need for such a large involvement of teachers,
which would minimize one of the major constraints to the implementation of interventions – teachers’ adherence.

- Demonstrates that the determinants of FV consumption remain relatively stable over time (between late childhood and adolescence), allowing the design of interventions to cover broader age groups taking into account the same core determinants.

**Human Subjects Approval Statement**

Ethical approval was granted by the University of Porto Ethics Committee.

**Acknowledgments**

The authors are grateful to all the participants, teachers and school administrators for their support and assistance in the data collection.

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Conclusions
5. Conclusions

The present thesis deals with the effects of Pro Greens intervention aimed at Portuguese schoolchildren. The objective of this research was four-fold. First, to assess differences in fruit and vegetable consumption and in its determinants after the intervention. Second, to investigate the determinants that are better predictors of the change in fruit and in vegetable intake. Third, to determine fruit and vegetable preference patterns in this population. Fourth, using a qualitative approach, to gain insight into the views of former Pro Greens intervention participants, including the identification of fruit and vegetable intake determinants as well as to gather suggestions to inform future program development.

The purpose of this final chapter is to summarize the main findings of the studies previously presented which constitute the core of this thesis, to address methodological issues, and to discuss implications for future research and practice.

5.1. Summary of main findings

These findings will be described according to the thesis organization.

**Paper I. Effects of a school-based intervention to promote fruit and vegetable consumption: the Pro Greens Project in Portugal**

- Pro Greens intervention led to a moderate increase in fruit and vegetable consumption, around 10 to 40 grams per day. No differences in the frequency of intake were observed between intervention and control schools;
- Soup constituted the greatest contributor for vegetable intake;
- Between baseline and follow-up measurements, the intervention group showed the following evolution in determinants of fruit and vegetable intake:
  - **Personal determinants**: higher knowledge of the recommendations for fruit and vegetable intake and higher preferences for fruit. Also, a significant increase in perceived barriers for fruit intake was found;
  - **Social environmental determinants**: children reported bringing fruit and vegetables to school more often. Parental facilitation and demand increased for
fruit (parents facilitated intake by preparing fruit to eat and by leading the child behaviour); for vegetables, there was an increase in parental encouragement (parents allowed their children to eat as many vegetables as they wanted);
- **Physical environmental determinants**: higher perceived availability at home and lower availability at school, both for fruit and for vegetables.

- Determinants of fruit intake generally scored higher than vegetable ones.

**Paper II. Personal, social and environmental predictors of fruit and vegetable consumption in 11-year-old Portuguese schoolchildren**

- Regression models explained 40.7% of the variance in fruit intake and 47.2% of the variance in children’s vegetable intake;

- Schoolchildren with lower baseline fruit intake, that perceived fewer barriers both at baseline and between baseline and follow-up measures, who reported a strong habit for fruit consumption at baseline and at the end of the study and that had a greater change on knowledge about the recommendations for fruit intake, were the ones with the highest increase in the frequency of fruit intake between the beginning and the end of the study;

- Schoolchildren who reported eating vegetables more frequently at the end of the study were those with lower intake at baseline. It is worth noticing that such children had less positive attitudes towards vegetables, a stronger intention to eat vegetables, higher scores on liking and perceived a stronger allowance from their parents at baseline. At follow-up these children were more knowledgeable of recommendations, acquired a stronger habit for vegetable consumption and perceived more availability of vegetables at home.

**Paper III. I like what I know: fruit and vegetable preferences and intake in Portuguese schoolchildren**

- Two preference patterns emerged: “High fruit and vegetable preferences”, mainly characterized and positively correlated with high preferences, both for fruit and vegetables (especially with all vegetables) and “High fruit and low vegetable preferences”, which was positively correlated with preferences for fruits but negatively correlated with vegetable preferences (except for green peas and tomatoes);
The two patterns elicit that higher preferences for fruit and/or vegetables are associated with positive scores on potential determinants of fruit and vegetable consumption. In the “High fruit and vegetable preferences” pattern, positive associations for the frequency of intake of fruit and vegetables were found, whereas the pattern “High fruit and low vegetable preferences” was characterized by a negative association with vegetable intake.

**Paper IV. Listen to the participants: adolescents’ views on an intervention to promote fruit and vegetable intake**

- Participants perceived Pro Greens to be a valuable intervention that allowed them to experiment different, unfamiliar fruits and vegetables;
- Students recognized to eat more fruit and vegetables at home and also at school after the intervention;
- A broad range of suggested activities to include in future programs emerged from focus groups: taste sessions, competitive activities that combined physical activity with healthy eating, theatre plays, use of celebrities, price campaigns and free distribution of fruits and vegetables were the most frequently mentioned.
- Major factors qualitatively identified as being determinant for fruit and vegetable choices and consumption were preferences, liking, physical and sensory attributes (mainly taste), habit, availability, accessibility and parental influences.

**5.2. Methodological issues**

This part addresses several methodological issues regarding the design of the study and the data collection procedure used for the studies presented in this thesis. These issues should be taken into account when interpreting our findings.

**5.2.1. Methodological issues related with the research design**

The first issue concerning the research design is the adopted sampling procedure. A convenience sample was used for this research, in which the most obvious criticism is that it was not representative of the population as a whole, and therefore, results cannot be generalized. This may result into a low external validity of the study. Additionally, there is also the risk of sampling bias. However, although the convenience
sampling was performed for the sake of feasibility, the intake frequency levels were comparable to those from a previous study that included a national representative sample (Yngve et al., 2005).

The limitations of a convenience sample were addressed by focusing on estimating parameters less subject to bias, such as regression coefficients.

Furthermore, we found baseline differences between intervention and control schools. Notably, both frequency of intake of fruit and vegetables and parental educational level were significantly higher in the intervention group. To solve the problem of baseline differences between the two groups, we adjusted all analyses for baseline differences.

It is known that a well conducted Randomized Control Trial (RCT) is regarded as the "gold standard" to assess the effects of an intervention. RCTs are well designed to solve the classic problem of causal inference - commonly referred to as the "Rubin Causal Model" (Rubin, 1974) - that arises when we can observe outcomes from individuals in the group that receive the "treatment" but we cannot observe what would have happened if these same individuals had not received the selected intervention. For example, we cannot observe how the same class of students would have performed on a standardized test if they had been taught using a different curriculum or teaching method. All we can observe from the children is how they did when taught by their current teacher with whatever that entails in terms of curriculum or pedagogical approach. To address this problem, random assignment produces a control group that systematically differs from the "treatment" group in only one way—receipt of the intervention being evaluated. Therefore, the control group yields information on how the "treatment" group would have fared under the counterfactual, or "untreated", condition.

A RCT has some drawbacks, particularly in the social sciences field; it is sometimes considered to be rigid, not feasible or even inappropriate for certain public health settings (Rychetnik et al., 2002). Many school-based interventions require flexible and community-driven strategies. RCTs have been described as unable to accommodate the complexity and flexibility that characterizes such programs, since it is very difficult to standardize school-based interventions: investigators are dependent on different
school systems, specificities at schools and different teachers. Therefore, it is very difficult to perform an intervention in exactly the same way in every school.

When performing interventions in school settings, it is not possible to conduct an individual randomization like recommended in a RCT, because children in the same class are influenced by each other. Moreover, most interventions exactly aim at the whole class or school. Therefore, in school-setting interventions, the school, or class is the unit of analysis.

As a matter of fact, the nature of the current study made it impossible to conduct random assignment at the individual level. The project required changes in the school environment, notably, a fruit break in the classroom. During the intervention, all activities were performed at class or school level.

Another limitation is related with the length of the follow-up period. The final assessment was conducted immediately after the end of the intervention, and the intervention lasted less than one school year. In such a short time span, it is not expected to find large differences in fruit and vegetable intake. Additionally, as changes are expected to be small, they can constitute a limiting factor for observing relationships between change in intake and its determinants. Ideally, the follow-up period should include at least two measurements. For instance, it would be more appropriate to conduct a first assessment at the end of the intervention and a second measurement in the following school year.

Although we acknowledge the limitations inherent to our methodology, the design used for the evaluation may have been the better and the feasible one given the circumstances, ensuring optimal exposure of the intervention.

5.2.2. Methodological issues related to the data collection procedure: questionnaire

The validated Pro Children questionnaire (De Bourdeaudhuij et al., 2005; Haraldsdottir et al., 2005) with minor changes was used in the present research. As aforementioned, this questionnaire aimed to measure fruit and vegetable consumption and determinants that might influence intake. Validity and reproducibility of the food frequency questions were considered to be satisfactory (Haraldsdottir et al., 2005). In what concerns 24-hour recall, the major limitation relies on the fact that fruit and vegetable consumption was only assessed on one weekday both at baseline and
follow-up measurements, and therefore it cannot be seen as representative of usual consumption including day-to-day variation and seasonal differences which may lead to differences in availability.

One of the possible limitations concerning the determinant part of the questionnaire has to do with the large number of determinants included; in order to avoid a lengthy questionnaire, most of the constructs were assessed with only a few items. Possibly, the inclusion of more items per construct would have increase the consistency of the scales and consequently, improve the construct validity of the measure. Still, this could constitute a major barrier in what concerns its application in schools. Nonetheless, the questionnaire has proven to be reliable, valid and easy-to-administer for assessing personal, social and environmental factors of potential influence on fruit and vegetable intake (De Bourdeaudhuij et al., 2005).

The answers to the questions about food intake and determinants of food intake may be liable to social desirability. It wasn’t possible to adjust for this possible confounding factor, as a tendency to give socially desirable answers was not assessed. However, we tried to reduce social desirability by stressing the anonymity of the respondents, and by emphasising that there were no right or wrong answers.

As described before, the reliability and validity of the constructs measuring intake and determinants were tested and regarded to be satisfactory. However, because the reliability was not optimal, the questionnaire might not have been sensitive enough to detect changes in intake nor in the determinants of intake. However, the measures were based on earlier studies reported in the literature and on expert consultations and multiple data sources to assess the implementation of the school curriculum were used.

Another issue is related with the internal (are the results really attributable to the intervention?) and external validity (can the results be generalized to other populations?) of the intervention. We cannot ensure that schools did not participate in other fruit and vegetable promoting activities during the Pro Greens study period. Although we have stressed the importance of not doing any other activities besides the Pro Greens intervention, or not doing any activities at all in control schools, we cannot rule out possible influences of other (for instances, mass media) campaigns
during the same time period. However, it is very likely that exposure to other ongoing interventions was similar between the intervention and the control groups. The results from the intervention study cannot be generalized, since the intervention was implemented in only two schools from the North region of Portugal. However, the objective was to evaluate the intervention effects and to assess if this would be an effective way to promote fruit and vegetable consumption. Also, as fruit and vegetables are perceived to be healthy and socially acceptable foods, there is a tendency to give socially desirable answers. This limitation can be more pronounced at the follow-up measurement in the intervention schools, as a result of the increased awareness and knowledge about the intake of fruit and vegetables.

5.3. Implications for future practice and research
Our results provide novel information for public health policy makers and practitioners and have implications for future research. Recommendations for practice are related to the implementation and continuity of the use of Pro Greens and similar interventions aimed at schoolchildren in the future, possibly addressing fruit and vegetables separately. There is a strong need for well designed studies to evaluate and compare the effects of combined fruit and vegetable interventions with interventions targeting separately fruits and vegetables and its determinants, since consumption of such foods are influenced by specific and different determinants. Furthermore, given that maintenance of the intervention effect is expected to decrease over time (Cockburn, 2004; Rohrbach et al., 2006), longer-term follow-up of these schools appears mandatory in order to determine whether the intervention impact is sustained. In addition, examination of the cost effectiveness of such strategies in achieving program implementation may assist policy makers and practitioners to most effectively allocate resources to improve the health of the community.
5.4. References


