HEALTH EDUCATION RESEARCH Vol.23 no.6 2008
Pages 997–1007
Advance Access publication 20 December 2007

Appreciation and implementation of a school-based intervention are associated with changes in fruit and vegetable intake in 10- to 13-year old schoolchildren—the Pro Children study

M. Wind[1,2]*, M. Bjelland[1], C. Pérez-Rodrigo[3], S. J. te Velde[4], C. Hildonen[1], E. Bere[5], K.-I. Klepp[1] and J. Brug[4]

Abstract

The purpose was to investigate the degree of implementation and appreciation of a comprehensive school-randomized fruit and vegetable intervention program and to what extent these factors were associated with changes in reported fruit and vegetable intake. The study was conducted among 10- to 13-year old children exposed to the intervention during the school year 2003–04 in Norway, Spain and the Netherlands. Children, parents and teachers completed questionnaires regarding (i) the implementation of the school curriculum, (ii) parental involvement, (iii) distribution of fruit and vegetables at school, (iv) children's appreciation of the project and (v) children's intake levels. Univariate analyses of covariance and multilevel multivariate regression analyses indicated that teacher-reported level of implementation of the school curriculum and schoolchildren's appreciation of the project were important determinants of changes in intake. The results point to the importance of optimal implementation of an attractive school curriculum.

[1]Department of Nutrition, Faculty of Medicine, University of Oslo, PO Box 1046, Blindern, 0316 Oslo, Norway, [2]Department of Public Health, Erasmus Medical Center, PO Box 2040, 3000 CA Rotterdam, the Netherlands, [3]Community Nutrition Unit, Department of Public Health, 48013 Bilbao, Spain, [4]EMGO Institute, VU University Medical Center, 1081 BT Amsterdam, the Netherlands and [5]Faculty of Health and Sport, University of Agder, 4604 Kristiansand S, Norway
*Correspondence to: M. Wind.
E-mail: marianne.wind@medisin.uio.no

Introduction

Literature reviews of state-of-the-art school-based interventions to promote consumption of fruit and vegetables among schoolchildren have provided useful information for developing and implementing successful interventions [1–6]. Interventions should be multicomponent, including school-based education aimed at children's behavioral determinants, parental involvement and changes in the school environment. Within the Pro Children project [7], a multicomponent intervention was developed that incorporated these elements [8]. Several interventions, including the Pro Children intervention, have shown to be effective [3, 9–13]. After 1 year, the children who received the Pro Children intervention consumed 57 g/day more fruits and vegetables compared with children who did not receive lessons on fruit and vegetables [9]. However, when implementing comprehensive multicomponent interventions, it is difficult to determine which components contributed to the effects. The most ideal situation would be to test the effects of intervention components separately before launching the comprehensive program. Since such a stepwise approach requires time and money and is often not feasible, process evaluations are recommended to explore mediators of effects [14, 15].

The aim of the present study was first to investigate (i) the quantity and quality of Pro Children activities that were implemented at school (school curriculum extent and fidelity), (ii) the degree of parental involvement as indicated by the number of activities that were carried out with (one of) the parents, (iii) exposure to fruit and vegetables as indicated by changes in weekly frequency of direct

doi:10.1093/her/cym078

intervention-related distribution of fruit and vegetables at school and (iv) appreciation of the project by the child. The second aim of this study was to assess whether these four process measures were associated with the short-term effects on schoolchildren's frequency of fruit and vegetable intake.

Methods

Data collection and management

The effects of the intervention were examined in a group-randomized trial design among 2106 10- to 13-year old schoolchildren from 62 schools with 117 classes, within three European countries. Surveys among children and parents were conducted prior to the intervention (September 2003), immediately after (May 2004) and at the end of the following school year (May 2005) in the intervention and control schools.

The first year of the intervention was most intensive, while during the second school year the intervention existed of continuation of the delivery of fruit and vegetables, and some booster sessions, i.e. all intervention children received a free fruit and vegetable cookery book and could continue the computer-tailored tool, while their parents received two newsletters. Process questions regarding the implementation and appreciation of the intervention were therefore included in the first follow-up questionnaires for children and parents, i.e. in May 2004. Children were asked to complete the questionnaires during school hours in the presence of a project worker and took a questionnaire home to be completed by one of its parents. Thus, the eligible sample of the current study consisted of 1115 children. Teachers were asked to complete two questionnaires: one halfway through, i.e. January 2004, and one at the end of the first intervention period, i.e. in May 2004. In addition, teachers were asked to keep pre-structured logbooks during the intervention period and return this at the end of the first intervention period, in May 2004.

All data were entered and cleaned at the national centers according to a standardized protocol. The national data sets were then pooled and further data processing and quality control of the intake data was carried out at the Pro Children Data Management Center, University of Vienna (for more information on protocols and data management, as well as the Pro Children questionnaires, please see www.prochildren.org) [16]. Ethical approval for the Pro Children project was obtained from the medical ethical committees in all countries. Responses were treated anonymously and confidential.

The intervention

The 'school curriculum' consisted of 16 lessons guided by worksheets and a web-based computer-tailored feedback tool that children were asked to complete three times during the intervention period. Four of the lessons involved homework assignments. 'Parents' were encouraged to be involved in the project by means of homework assignments of their child, parental newsletters and a parent version of the web-based computer-tailored tool that enabled them to get personalized feedback on their own fruit and vegetable intake levels. The 'distribution of fruit and vegetables at school' differed between the three countries, since the organization was adapted to each country's situation. In Norway and Spain, children were invited to subscribe to an existing fruit and vegetable program and received a piece of fruit or a carrot during lunch or during a fruit break each school day for which the parents pay a fee (independent of the intervention program). In the Netherlands, all intervention children received a piece of fruit, a carrot or a tomato for free during a fruit break two schooldays per week. A more detailed presentation of the intervention is published elsewhere [8].

The implementation of above mentioned that the intervention started in October 2003 and lasted until the end of April 2004. To guide the teachers in implementing the intervention program, all eligible teachers were invited to take part in a 1-day teacher training prior to the start of the intervention, and were provided with a teachers' project manual. The teachers were encouraged to implement all lessons and to follow the suggested schedule, so that the school-based activities and the activities for

which parental support was needed were spread throughout those 7 months.

Measures

Intake

Primary outcome measures were frequency of usual fruit and vegetable intake. Frequency of fruit intake was assessed by one food frequency question: 'How often do you usually eat fresh fruit'. Mean total frequency of vegetable intake per day was calculated by the sum of three food frequency questions: 'How often do you usually eat of salad/grated, raw and cooked vegetables'. All four frequency questions had eight response alternatives ranging from 'never' (0) to 'every day, more than twice per day' (7).

Prior to this study, two separate studies were conducted to assess the validity and reproducibility of the food frequency questions [17]. The validity study was conducted in a population of children from four of the Pro Children countries (Denmark, Norway, Iceland and Portugal), and showed that Spearman rank correlations for frequency of fruit and vegetable intake as assessed by the Pro Children food frequency questions and a 7-day food record ranged between 0.38 and 0.51 for fruit and between 0.43 and 0.51 for vegetables. For fruit, between 26 and 48% were classified into the same quartile and 70 and 84% into the same or adjacent quartile of intake. For vegetables, between 22 and 39% were classified into the same quartile and 75 and 88% into the same or adjacent quartile of intake The reliability study was conducted in a population of children from six of the Pro Children countries (Denmark, Norway, Iceland, Belgium, Portugal and Spain) and showed that test–retest Spearman rank correlations were between 0.47 and 0.77 for fruit and between 0.59 and 0.74 for vegetables. Specific information on the development, reliability and validity of the intake part of the Pro Children questionnaire has been published elsewhere [17].

Intervention characteristics

In order to assess both the quantity (dose delivered) and the quality (fidelity) of the 'school curriculum', teachers were asked whether they had implemented each lesson at all ('yes' = 1, 'no' = 0), and whether they had followed the instructions in the teachers' manual ('yes all of it' = 1, 'no some of it' = 0.5, 'no not at all' = 0). By combining the quantity and quality of the 16 activities, a composite score was calculated (0–16). For this purpose, mainly data from the teacher questionnaires were used, since most teachers completed these questionnaires. The logbooks were used to complete missing data on the delivery and fidelity of the implementation of the school curriculum.

'Parental involvement' was assessed by asking the parents ('yes' = 1, 'no' = 0), whether they had helped their children doing the four homework assignments that specifically asked for their input, whether they had conducted the computer-tailored tool for adults, and whether they had seen at least two of the three newsletters. Parents were also asked whether they talked about the project with their child ('often' = 1, 'sometimes' = 0.5, 'no' = 0). Subsequently, a total score for parental involvement was calculated (0–7). Cronbach's alpha of those seven items was 0.79.

To assess changes in 'distribution of fruit and vegetables at school', the difference between weekly frequency of intervention-induced distribution of fruit and vegetables, measured at follow-up and baseline, was computed.

In addition to these three intervention characteristics, children were asked whether they 'appreciated the project' by indicating whether they liked eight different project activities (e.g. whether they liked doing homework assignments with their parents, the computer-tailored test, eating fruit and vegetables at school, the website and the workbook) and the project in general ('liked it a lot' = 3, 'liked it' = 2, 'did not like it' = 1). When calculating a mean score for appreciation (1–3), the number of activities that were implemented at school according to the schoolteachers was taken into account, i.e. when a child did indicate he/she liked an activity, but this activity was reported as not conducted by the teacher, the child's answer was considered not to be reliable and was omitted. When the child, for example, indicated he/she liked to

make a recipe for an international recipe competition, but according to the teacher this lesson was not implemented at all and did not send in any recipes, the answer of the child was omitted.

Respondents and preliminary data handling

Due to lack of informed consent or being sick on the day of data collection, 117 schoolchildren did not participate at baseline (response rate = 89.5%). At follow-up, 155 did not participate, due to illness on the day of data collection or having moved to another school during the intervention period (response rate = 86.1%). In total, 998 children who were exposed to the Pro Children intervention completed the baseline survey. Nine children were excluded from analyses due to missing values on the food frequency measures at baseline. Besides frequency measures, a 24-hour recall was included in the questionnaire. Another 23 children were excluded due to overreporting (>1000 g of fruit and vegetables the previous day). Of the remaining 966 children, 81 did not complete the follow-up questionnaire while 17 were excluded due to overreporting in the 24-hour recall and/or incompleteness of the food frequency measures at follow-up. Thus, complete data on all intake measures were available for 868 children. Teacher reports on both the first (80.3%) and second (83.9%) teacher questionnaire and the logbooks (82.1%) were used to assess implementation of the school curriculum. During the school year, only one school dropped out on request of the school staff. Complete data on the implementation of the school curriculum were available for 51 out of 56 classes (data missing from 50 children). In Spain, data on frequency of the fruit break were lacking for four classes (data missing from 86 children). Twenty-six children had not completed the questions on appreciation of the project.

The parent questionnaires were completed by 863 parents (99.4%) at baseline and 632 (72.8%) at follow-up. Response at follow-up was higher in Spain (83.4%) and Norway (79.8%) than in the Netherlands (56.1%). Of the 632 parents who completed the follow-up questionnaire, 559 parents completed the questions regarding the process data (88.4%). Due to missing values on the four intervention characteristics, the number of cases included in the different analyses varied slightly.

Statistical analyses

To assess potential dropout bias, both among children and parents, multiple logistic regression analysis was conducted with dropout as dependent variable and country, gender, age, immigrant status, living circumstances, mother's educational level and child's intake at baseline as independent variables. In addition, parents who did complete the process questions were compared with parents who completed the questionnaire but not the process questions (559 versus 73).

For the statistical tests, the values of the variables of degree of implementation of the school curriculum, parental involvement and appreciation of the intervention were recoded into tertiles: i.e. 'low' (1), 'medium' (2) and 'high' (3). A change in intervention-induced distribution of fruit and vegetables was recoded into 'an increase' (1), 'no change' (0) or 'a decrease' (−1).

Exploratory analyses to assess associations between these different levels of the intervention characteristics, and changes in frequency of fruit and vegetable intake were first conducted. Univariate analyses of covariance (with Bonferoni *post hoc* test) were conducted with differences in frequency of fruit and vegetable intakes between baseline and follow-up as dependent variables, and different levels of the intervention characteristics, gender, country and intake at baseline as independent variables. Since implementation and appreciation of the intervention may be dependent on local circumstances and may therefore differ somewhat between and within countries, analyses will be done for the three separate countries as well.

Potential interaction effects of the process measures with gender, age, mother's educational level, family characteristics and immigrant status were explored with SPSS version 14.0 (SPSS Inc., 2005).

Subsequently, multilevel analyses with random intercepts were conducted in order to account for the nested design (MlwiN 1.10.0007) [18]. Associations between the intervention characteristics and effects of the intervention, i.e. the differences in frequency of fruit and vegetable intake between baseline and follow-up, were assessed. For these analyses, the process measures were used as independent continuous variables, since the distribution of those variables was considered to be normal. The multilevel regression analyses were adjusted for gender, country and baseline value of the outcome measure. Standardized regression coefficients (b) for the intervention characteristics were calculated.

Two multiple regression models were tested. First the full model was analyzed, including all intervention characteristics. Due to lower response rates among the parents, a second model was conducted without including parental involvement. All analyses were carried out on the whole sample and separately for each country. All P values are two sided and 5% level of significance was used.

Results

Dropout

Multiple logistic regression of dropout among children at first follow-up showed that children from Norway [odds ratio (OR) = 0.36, 95% confidence interval (CI) = 0.67–0.77] dropped out significantly less often than children from Spain and the Netherlands.

Multiple logistic regression revealed that parents from families in which both parents were born in the research country (OR = 0.35, 95% CI = 0.23–0.52) and parents from families in which both parents of the child lived together (OR = 0.45, 95% CI = 0.26–0.76) dropped out significantly less often than parents from families in which at least one parent was born abroad or parents no longer lived together. Parents who took part in the follow-up questionnaire, but did not respond to the process questions, did not differ from those who completed also those items. Characteristics of the study population are shown in Table I.

Table I. *Characteristics of the study population (n = 868); the Pro Children study*

Characteristics	*n*	% or mean (standard deviation)
Country (%)		
Norway	243	28.0
Spain	305	36.8
the Netherlands	320	35.2
Gender (%)		
Boys	392	45.2
Girls	476	54.8
Age child, years	844	10.7 (0.54)
Living circumstances (%)		
Live with both of own parents	658	76.2
Do not live with both of own parents	206	23.8
Live with two adults	738	85.4
Live in single-parent family	126	14.6
Parental country of origin (%)		
Both parents born in the country where the study was conducted	595	73.1
At least one parent born in a country other than where the study was conducted	219	26.9
Educational level mother/female caretaker (%)		
<10 years	207	31.8
⩾10 years	443	68.2

Degree of intervention implementation

The mean number of lessons that was implemented by the teachers differed significantly between all three intervention sites, and ranges from two to all 16 lessons ($P < 0.01$) (Table II). The degree of implementation was significantly higher in Norway ($P < 0.01$) compared with Spain and the Netherlands, and significantly lower in the Netherlands ($P < 0.01$) than in Spain and Norway. All countries showed a similar downward trend in the implementation of the school curriculum: all schoolteachers implemented the first two worksheets while the last worksheets were only implemented by one out of three teachers.

Mean score on appreciation of the project in the total sample was 2.30 (SD = 0.47) and differed significantly between the three countries, with Norwegian children being more positive to the project than were Dutch and Spanish children ($P < 0.01$).

Table II. *Mean scores, standard deviations (SD) and results of ANOVAs to test for differences in the scores for children's appreciation of the project, extent and fidelity of the school curriculum (based on teachers' reports) and parental involvement; the Pro Children study*

Characteristics	Teachers' report of school curriculum implementation (0–16)			Children's appreciation of the project (1–3)			Parental involvement (0–7)		
	n	Mean (SD)	*P*-value	*n*	Mean (SD)	*P*-value	*n*	Mean (SD)	*P*-value
Country									
Total	818	9.1 (3.0)	<0.001	842	2.3 (0.5)	<0.001	559	3.3 (1.9)	0.002
Norway	225	10.9 (2.4)		240	2.4 (0.4)		160	3.4 (1.8)	
Spain	320	9.4 (1.9)		297	2.3 (0.5)		233	3.5 (1.9)	
Netherlands	273	7.4 (3.5)		305	2.2 (0.5)		166	2.8 (1.9)	
Gender									
Boys	369	9.3 (3.0)	0.392	380	2.3 (0.5)	0.128	237	3.1 (2.0)	0.042
Girls	449	9.1 (3.0)		462	2.3 (0.4)		322	3.4 (1.8)	

The mean number of activities that parents were involved in also differed between countries (ranged from none to all seven), with significantly higher scores in Norway ($P < 0.05$), and significantly lower in the Netherlands ($P < 0.05$). Among girls, the percentage of parents who were involved in any activity was higher than among boys (69.7 versus 62.4%, $P < 0.05$).

Parents of girls also reported involvement in more activities together with their child than did parents of boys ($P < 0.05$). Parental involvement was higher among children who lived with both parents (mean = 3.3, SD = 1.9) ($P < 0.05$) or with two adults (mean = 2.9, SD = 1.8) ($P < 0.05$) than among children who did not live with both parents (mean = 2.9, SD = 1.8) or with only one adult (mean = 2.8, SD = 1.7).

None of the Dutch children received fruit and vegetables at school prior to the intervention, while all of them received two pieces of fruit and vegetables per week as part of the intervention. In Norway and Spain, children were able to change their subscription to the ongoing school fruit program, but few children did so. In total, 84.5% of the Norwegian and 79.0% of the Spanish children did not change their subscription status. Due to lack of variability in changes in distribution of fruit and vegetables in all three countries, this variable was not included in the remaining analyses.

Degree of school curriculum implementation and intervention appreciation was not associated with gender or age of the child, mother's educational level, family characteristics and immigrant status, when adjusted for country (data not shown). In addition to the pooled data, we conducted analyses on the three countries separately.

Intervention characteristics associated with intake

The full model, including all intervention characteristics, did not reveal substantial differences than the second model without including parental involvement. Therefore, only results from the full model are presented, and only significant differences between both models are discussed.

Fruit intake

Table III shows that the appreciation of the project ($P < 0.01$) and the degree of implementation of the school curriculum ($P < 0.05$) were significantly associated with changes in frequency of fruit intake.

Children who scored highest on appreciation of the intervention showed a significantly higher increase in intake compared with children who scored medium ($P < 0.01$) or low ($P < 0.01$) on appreciation. No differences were found between low and medium appreciation ($P > 0.05$). The strongest

Table III. *Adjusted means[a] and 95% CIs of frequency of fruit and vegetable intake for low, medium and high implementation and appreciation of the school curriculum and parental involvement; the Pro Children study*

Intervention characteristic	Group	Total sample			Norway			Spain			The Netherlands		
		n	Adjusted mean (times per day)	95% CI	*n*	Adjusted mean (times per day)	95% CI	*n*	Adjusted mean (times per day)	95% CI	*n*	Adjusted mean (times per day)	95% CI
Fruit													
Appreciation (1–3)	Low (<2)	256	−0.13	−0.23, −0.02	27	−0.19	−0.41, 0.03	97	−0.11	−0.27, 0.06	112	−0.13	−0.30, 0.03
	Medium (2–2.5)	285	0.00	−0.10, 0.10	49	−0.08	−0.25, 0.08	98	0.03	−0.13, 0.20	101	0.04	−0.13, 0.21
	High (>2.5)	327	0.28	0.18, 0.37	110	0.39	0.25, 0.54	125	0.24	0.10, 0.39	92	0.20	0.19, 0.38
School curriculum (0–16)	Low (<7.5)	224	−0.02	−0.13, 0.10	27	−0.02	−0.29, 0.33	73	−0.03	−0.22, 0.16	124	−0.03	−0.19, 0.12
	Medium (7.5–10)	318	0.00	−0.09, 0.09	39	−0.16	−0.41, 0.10	168	0.07	−0.06, 0.20	111	−0.02	−0.18, 0.15
	High (>10)	326	0.18	0.08, 0.28	177	0.18	0.06, 0.30	79	0.18	−0.03, 0.37	70	0.19	−0.02, 0.40
Parental involvement (0–7)	Low (<2.5)	186	0.03	−0.10, 0.15	45	0.21	−0.05, 0.47	71	−0.06	−0.26, 0.13	70	0.01	−0.20, 0.23
	Medium (2.5–4)	164	0.06	−0.07, 0.20	56	0.14	−0.04, 0.37	58	−0.11	−0.33, 0.11	50	0.18	−0.07, 0.43
	High (>4)	209	0.19	0.07, 0.31	59	0.19	−0.03, 0.41	104	0.20	0.04, 0.36	46	0.13	−0.14, 0.40
Vegetables													
Appreciation (1–3)	Low (<2)	256	−0.09	−0.21, −0.02	47	−0.32	−0.58, −0.06	97	−0.02	−0.14, 0.18	112	−0.06	−0.27, 0.16
	Medium (2–2.5)	285	−0.02	−0.13, −0.08	86	−0.22	−0.41, −0.03	98	0.06	−0.10, 0.22	101	0.06	−0.16, 0.29
	High (>2.5)	327	0.37	0.27, 0.48	110	0.26	0.09, 0.43	125	0.39	0.25, 0.54	92	0.43	0.20, 0.67
School curriculum (0–16)	Low (<7.5)	224	−0.05	−0.20, 0.06	27	−0.04	−0.39, 0.31	73	−0.02	−0.21, 0.17	124	−0.03	−0.23, 0.18
	Medium (7.5–10)	318	0.12	0.01, 0.23	39	−0.13	−0.43, 0.16	168	0.15	0.03, 0.28	111	0.26	0.04, 0.48
	High (>10)	326	0.21	0.09, 0.32	177	0.00	−0.13, 0.14	79	0.41	0.23, 0.59	70	0.20	−0.07, 0.47
Parental involvement (0–7)	Low (<2.5)	186	−0.02	−0.16, 0.11	45	−0.02	−0.32, 0.28	71	−0.06	−0.27, 0.13	70	0.03	−0.20, 0.27
	Medium (2.5–4)	164	−0.03	−0.17, 0.11	56	−0.19	−0.45, 0.08	58	−0.10	−0.12, 0.33	50	0.00	−0.28, 0.27
	High (>4)	209	0.28	0.15, 0.40	59	0.14	−0.13, 0.40	104	0.36	0.19, 0.52	46	0.25	−0.03, 0.54

Underlined: significant at the $P = 0.05$ level.
[a]Adjusted for gender, country and intake at baseline.

increase in intake was found among children who had completed >10 lessons at school compared with those who had done between 7 and 10 lessons ($P < 0.05$) or ⩽seven lessons ($P < 0.05$). No significant differences were found between low and medium degree of implementation ($P > 0.05$).

No significant associations were found between parental involvement and changes in frequency of fruit intake ($P > 0.05$).

Vegetable intake

Significant positive associations were found between appreciation of the project ($P < 0.01$), the degree of implementation of the school curriculum ($P < 0.05$), parental involvement ($P < 0.01$) and changes in frequency of vegetable intake.

Children who scored highest on appreciation of the intervention showed a significantly higher increase in intake compared with children who scored medium ($P < 0.01$) or low ($P < 0.01$) on appreciation. No differences were found between low and medium appreciation ($P > 0.05$).

The strongest increase in intake was found among children who had completed > 10 lessons at school, compared with those who had done seven lessons or fewer ($P < 0.01$). A significant difference was also found between low and medium degree of implementation ($P < 0.05$). No significant difference was found between medium and high degree of implementation ($P > 0.05$).

Children with highest parental involvement showed the highest increase in frequency of vegetable intake, compared with children who scored medium ($P < 0.05$) or low on parental involvement ($P < 0.05$). No differences were found between low and medium involvement ($P > 0.05$).

The multilevel analyses revealed results comparable to those of the exploratory analyses of variance. Appreciation (fruit: standardized regression coefficient, $b = 0.16$, 95% CI = 0.08–0.32; vegetables: $b = 0.18$, 95% CI = 0.11–0.39) and the school curriculum (vegetables: $b = 0.11$, 95% CI = 0.02–0.14) showed significant associations with changes in intake. Associations between the school curriculum and changes in fruit intake were only significant when parental involvement was excluded from the analyses ($b = 0.09$, 95% CI = 0.02–0.11). Parental involvement was significantly associated with changes in vegetable intake ($b = 0.07$, 95% CI = 0.01–0.11).

Country-specific analyses showed similar results for changes in fruit and vegetable intake (Table III). Although some effect sizes did not always remain significant, magnitudes of effect sizes were comparable to those found in the total sample. In all countries, a significantly higher increase in intake was found among the children who scored highest on appreciation of the intervention, compared with children who scored medium or low on appreciation.

Country-specific exploratory analyses showed that only in Spain significant relationships were found between parental involvement and changes in fruit intake ($P < 0.05$), and between parental involvement ($P < 0.01$), the degree of implementation of the school curriculum ($P < 0.01$) and changes in vegetable intake.

Multilevel analyses showed a significant association between the school curriculum and changes in fruit intake in Norway ($b = 0.16$, 95% CI = 0.01–0.17) and change in vegetable intake in the Netherlands ($b = 0.12$, 95% CI = 0.02–0.16).

Discussion

The results from this study demonstrate that the degree of implementation of the Pro Children intervention and the children's appreciation of the intervention are associated with higher intake levels of fruit and vegetables.

In all three countries, the content of the school curriculum and parental activities were comparable [8]. However, implementation and appreciation of the intervention may have been dependent on local circumstances and may therefore have differed somewhat between and within countries. To better interpret the effects of the intervention on changes in frequency of fruit and vegetable intake [9], an assessment was made regarding the degree of implementation and appreciation of three Pro

Children intervention components and their association with changes in fruit and vegetable intake.

This study shows that the schoolchildren's appreciation of the intervention was associated with changes in fruit and vegetable intake. Bere and colleagues [19] also found stronger effects of a similar intervention among the children who enjoyed the intervention the most. This suggests the importance of involving children from the early stages when developing an intervention, in order to make attractive interventions. Results from this study indicated that the children preferred the more practical lessons, such as a taste testing, doing computer-tailored test, eating fruit and vegetables at school and making a recipe.

Our study also revealed that the school curriculum delivery and fidelity were associated with changes in fruit and vegetable intake. Similar results have been found in other studies [20, 21].

The degree of implementation of the school curriculum was not optimal. Since the degree of implementation was related to the outcome, this implies that effects of the intervention could have been better if the school curriculum had been more fully implemented. The observed highest mean number of implemented lessons in Norway might be explained by the fact that at most Norwegian schools a home economic teacher was responsible for the intervention. This might have been a better setting compared with Spain and the Netherlands where the regular classroom teachers were responsible for implementing the Pro Children intervention. To ensure optimal implementation, teachers should be involved in the curriculum development and implementation plan. Moreover, determinants of implementing the school curriculum should be further investigated. Lack of time might be a barrier, therefore more research is needed to assess the most important determinants of schoolchildren's fruit and vegetable intake so that the curriculum can become even more focused, requiring fewer school hours.

As in other studies, parental involvement was rather low [20, 22]. In the Dutch sample, almost 50% of the parents of the participating children in the Rotterdam schools were of non-Dutch origin. Language barriers might have caused low involvement in homework assignments. The children were the least enthusiastic about the homework assignments which had to be carried out with one of their parents. Making these parent-related activities more attractive might therefore lead to stronger parental involvement as well as stronger associations with changes in intake.

Parental influences have shown to be important determinants of children fruit and vegetable intake [1, 2, 23, 24]. We did find significant associations between parental involvement and changes in vegetable intake, and it is recommended to further investigate the determinants of (non-)participation in school-based health-promoting activities among parents.

An important strength of this study is that the intervention was tested in three very different geographical and cultural settings. Furthermore, validated instruments were used to assess intake [17]. The findings reported in this study should, however, also be considered in the light of some limitations. The dropout analyses among parents revealed that a selective group of parents completed the first follow-up questionnaire; parents from families in which at least one parent was born in a country other than the research country and parents from families in which both the parents of the child no longer live together were more likely to drop out. Results presented might therefore not be fully representative, especially for the Dutch sample where the participation rate was lowest.

The validity and reliability of the assessment of the four intervention characteristics has not been tested. Teachers could have given socially desirable answers and overestimated the implementation. A validation study comparing three different methods (i.e. classroom observations, teacher self-reports and post-implementation interviews) to assess implementation of a school-based health curriculum by Resnicow *et al.* [25] showed that different methods lead to different implementations rates. In Resnicow's study, implementation rates based on teachers' self-reports were higher, suggesting that overestimation of implementation might also have been the case in our study for which we used

teachers' self-reports. However, the measures we used were based on earlier studies [26] and expert consultations. Face and content validity were seen to be high. Moreover, we used multiple data sources to assess the implementation of the school curriculum.

Observations, questionnaires and interviews are a common combination to assess implementation [25, 27, 28]. We mainly used questionnaires in which detailed data were collected, while logbooks were used to complete missing data. Both these self-reports were used to calculate implementation scores for the school curriculum in which quality and quantity, two important dimensions of implementation [26, 29], were combined. Relying on only one data source, however, might reveal less reliable measures. Extensive interviewing of the teachers immediately after the intervention period or dual observations of fidelity might have been more valid than self-reports. Moreover, more in-depth data might have provided more information on why schools were unable to implement the entire curriculum and why schools had success or failure in involving parents.

Another limitation of this study is the lack of ability to state causality. When assessing associations between process measures and changes in intake, it might also be that children who already eat more fruit and vegetables, or who like fruit and vegetables better, appreciate the project more or are more active in stimulating their parents to conduct activities with them. However, this study does help to shed some light on how the Pro Children intervention changed effects on intake of fruit and vegetables. A next step, as suggested by Baranowski and Jago [29], would be to assess effects of the Pro Children intervention on mediating factors, such as psychosocial factors. Subsequently, a similar study can be recommended using those mediating factors as outcome measures. This study shows that the implementation of a school curriculum is crucial to have effect on the children's intake of fruit and vegetables. Furthermore, it shows the importance of developing an intervention that is appreciated by the children. Our study therefore provides support for the importance of a process evaluation; however, validation studies of process measures are recommended.

Funding

Commission of the European Communities, specific Research and Technological Development program 'Quality of Life and Management of Living Resources' (QLK1-2001-00547) 'Promoting and Sustaining Health through Increased Vegetable and Fruit Consumption among European Schoolchildren' (Pro Children).

Acknowledgements

The study does not necessarily reflect the Commission's views and in no way anticipates the Commission's future policy in this area. Special thanks goes to all the schoolchildren, parents and teachers who took the time to participate in this intervention study.

Conflict of interest statement

None declared.

References

1. Rasmussen M, Krølner R, Klepp K-I *et al*. Determinants of fruit and vegetable consumption among children and adolescents: systematic review of the literature. Part I: quantitative studies. *Int J Behav Nutr Phys Act* 2006; **3**: 22.
2. Blanchette L, Brug J. Determinants of fruit and vegetable consumption among 6-12-year-old children and effective interventions to increase consumption. *J Hum Nutr Diet* 2005; **18**: 431–443.
3. Knai C, Pomerleau J, Lock K *et al*. Getting children to eat more fruit and vegetables: a systematic review. *Prev Med* 2006; **42**: 85–95.
4. Contento I, Balch GI, Bronner YL *et al*. The effectiveness of nutrition education and implications for nutrition education policy, programs and research: a review of research. *J Nutr Educ* 1995; **27**: 279–418.
5. Hoelscher DM, Evans A, Parcel GS *et al*. Designing effective nutrition interventions for adolescents. *J Am Diet Assoc* 2002; **102**: S52–S63.
6. Van der Horst K, Oenema A, Ferreira I *et al*. A review of environmental correlates of obesity-related dietary behaviors in youth. *Health Educ Res* 2007; **22**: 203–226.
7. Klepp KI, Pérez-Rodrigo C, De Bourdeaudhuij I *et al*. Promoting fruit and vegetable consumption among European

schoolchildren: rationale, conceptualization and design of the Pro Children project. *Ann Nutr Metab* 2005; **49**: 212–20.
8. Pérez-Rodrigo C, Wind M, Hildonen C *et al*. The Pro Children intervention: applying the Intervention Mapping Protocol to develop a school-based fruit and vegetable promotion programme. *Ann Nutr Metab* 2005; **49**: 267–77.
9. te Velde SJ, Brug J, Wind M. Effects of a comprehensive fruit and vegetable promoting school-based intervention in three European countries: the Pro Children Study.*Br J Nutr* 2007; E-pub ahead of print: Oct 22.
10. French SA, Wechsler H. School-based research and initiatives: fruit and vegetable environment, policy, and pricing workshop. *Prev Med* 2004; **39**: S101–7.
11. Bere E, Veierod MB, Klepp KI. The Norwegian School Fruit Programme: evaluating paid vs. no-cost subscriptions. *Prev Med* 2005; **41**: 463–70.
12. Bere E, Veierod MB, Bjelland M *et al*. Outcome and process evaluation of a Norwegian school-randomised fruit and vegetable intervention: Fruits and Vegetables Make the Marks (FVMM). *Health Educ Res* 2006; **21**: 258–67.
13. Bere E, Veierod MB, Bjelland M *et al*. Free school fruit sustained effect 1 year later. *Health Educ Res* 2006; **21**: 268–75.
14. Bartholomew KL, Parcel GS, Kok G *et al*. *Intervention Mapping: Designing Theory- and Evidence-based Health Promotion Programs*. Mountain View, CA: Mayfield Publishing Company, 2001.
15. Green LW, Kreuter MW. *Health Promotion Planning: An Educational and Ecological Approach*. Mountain View, CA: Mayfield, 1999.
16. Pro Children Consortium: *The Pro Children Project*. Available at: http://www.prochildren.org. Accessed: 13 July 2005.
17. Haraldsdóttir J, Thórsdóttir I, de Almeida MD *et al*. Validity and reproducibility of a precoded questionnaire to assess fruit and vegetable intake in European 11- to 12-year-old schoolchildren. *Ann Nutr Metab* 2005; **49**: 221–7.
18. Rabash J, Browne W, Goldstein H *et al*. *A User's Guide to MlwiN*. London: Institute of Education, 1999.
19. Bere E, Klepp KI. Changes in accessibility and preferences predict children's future fruit and vegetable intake. *Int J Behav Nutr Phys Act* 2005; **2**: 15.
20 Story M, Mays RW, Bishop DB *et al*. 5-a-day Power Plus: process evaluation of a multicomponent elementary school program to increase fruit and vegetable consumption. *Health Educ Behav* 2000; **27**: 187–200.
21. Horne PJ, Tapper K, Lowe CF *et al*. Increasing children's fruit and vegetable consumption: a peer-modelling and rewards-based intervention. *Eur J Clin Nutr* 2004; **58**: 1649–60.
22. Davis M, Baranowski T, Resnicow K *et al*. Gimme 5 fruit and vegetables for fun and health: process evaluation. *Health Educ Behav* 2000; **27**: 167–76.
23. Wind M, De Bourdeaudhuij I, te Velde SJ *et al*. Correlates of fruit and vegetable consumption among 11 year-old Belgian-Flemish and Dutch schoolchildren. *J Nutr Educ Behav* 2006; **38**: 211–21.
24. Patrick H, Nicklas TA. A review of family and social determinants of children's eating patterns and diet quality. *J Am Coll Nutr* 2005; **24**: 83–92.
25. Resnicow K, Davis-Hearn M, Smith M *et al*. How best to measure implementation of school health curricula: a comparison of three measures. *Health Educ Res* 1998; **13**: 239–50.
26. Baranowski T, Stables G. Process evaluations of the 5-a-day projects. *Health Educ Behav* 2000; **27**: 157–66.
27. Parsons C, Stears D. Evaluating health-promoting schools: steps to success. *Health Educ* 2000, 7–15.
28. McGraw SA, Sellers D, Stone E *et al*. Measuring implementation of school programs and policies to promote healthy eating and physical activity among youth. *Prev Med* 2000, S86–97.
29. Baranowski T, Jago R. Understanding the mechanisms of change in children's physical activity programs. *Exerc Sport Sci Rev* 2005; **33**: 163–8.

Received on May 30, 2007; accepted on October 30, 2007