

The effects of a middle-school healthy eating intervention on adolescents' fat and fruit intake and soft drinks consumption

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Abstract

Objectives: To evaluate the effects of a middle-school healthy eating promotion intervention combining environmental changes and computer-tailored feedback, with and without an explicit parent involvement component.

Design: Clustered randomised controlled trial.

Setting: Fifteen West-Flemish (Belgian) middle schools.

Subjects: A random sample of 15 schools with 2991 pupils in 7th and 8th grades was randomly assigned to an intervention group with parental support ($n = 5$), an intervention group without parental support ($n = 5$) and a control group ($n = 5$). In these 15 schools an intervention combining environmental changes with computer-tailored feedback was implemented. Fat and fruit intake, water and soft drinks consumption were measured with food-frequency questionnaires in the total sample of children.

Results: In girls, fat intake and percentage of energy from fat decreased significantly more in the intervention group with parental support, compared with the intervention alone group (all $F > 3.9$, $P < 0.05$) and the control group (all $F > 16.7$, $P < 0.001$). In boys, there were no significant decreases in fat intake ($F = 1.4$, not significant (NS)) or percentage of energy from fat ($F = 0.7$, NS) as a result of the intervention. No intervention effects were found in boys or in girls for fruit ($F = 0.5$, NS), soft drinks ($F = 2.6$, NS) and water consumption ($F = 0.3$, NS).

Conclusions: Combining physical and social environmental changes with computer-tailored feedback in girls and their parents can induce lower fat intake in middle-school girls. However, to have an impact on the consumption of soft drinks and water, governmental laws that restrict the at-school availability of low-nutritive products may be necessary.

Keywords
Tailored advice
Environment
Children

In past years dietary behaviours have moved in an unhealthy direction in US youth^{1,2}. Also in Europe, children and adolescents have poor dietary habits^{3–5}. The transition from childhood into adolescence often results in diets becoming less healthy⁶. Previous research in adolescents has revealed that saturated fat intake is far above recommendations, fruit intake is less than desirable³ and soft drinks consumption is too high³. An unhealthy diet during adolescence can negatively affect growth and development⁷ and is likely to persist into adulthood^{8,9}. High intakes of energy and fat, low intake of fruit and excessive consumption of soft drinks have been associated with higher risk of becoming overweight and obese as well as increased risk for diabetes, hypertension, cancer and cardiovascular diseases^{2,7,10–14}.

The immediate and long-term health of adolescents can be improved by the effective promotion of healthy eating in young people^{1,7,14}. Schools are the preferred setting to promote healthy eating in adolescents¹⁵ because they offer the opportunity to combine nutrition education with changes in the school environment, and parents may also become involved via school-based programmes. Existing evidence indicates that adolescents' food choices are influenced by the food offered in vending machines, shops or at events at school^{1,16,17}. Therefore changes in school policies affecting the school environment can improve the opportunities for health-enhancing food choices^{15,17,18}. Nutrition education can be offered repeatedly in the classroom with the aim of influencing the motivation, ability and self-confidence to eat a healthy diet. However, standard

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health education curricula provide youth with generic information. In the last decade a new health education strategy has emerged, computer-tailored feedback¹⁹, which can be used in classroom nutrition education. Compared with generic class-based health education curricula, computer-tailored messages respond better to the personal motivational and enabling factors that influence adolescents' dietary behaviours²⁰. The increased relevance of the messages results in higher attention and motivational impact²⁰. Especially for fat intake, computer-tailored interventions have already been found to be more effective than non-tailored approaches^{20–22}. Finally, through schools a direct link can also be established with the home environment. Parental influences are important determinants of adolescents' food preferences and adolescents' consumption of healthy food products is associated with the household availability of these products²³. Therefore it is assumed that parental involvement will increase intervention effects.

To date, only a few school-based interventions have tried to target food behaviours in middle-school children and in these studies no comparisons were made between interventions with and without parental support²⁴. M-span, a middle-school intervention aimed at increasing the availability and promotion of lower-fat food choices, was not effective in reducing fat intake at school in adolescents of the intervention schools²⁵. The TACOS study (Trying Alternative Cafeteria Options in Schools) was effective in increasing the sales of lower-fat foods and decreasing the sales of high-fat foods, but it was not effective in changing adolescents' self-reported fat intake²⁶. The middle-school health education programme used in the Planet Health intervention was effective in girls in increasing fruit and vegetable consumption, but had limited effects on energy from fat²⁷.

The aim of the present study was to evaluate the effects of a healthy food intervention in middle schools, combining changes in the school environment with nutrition education through interactive computer-tailored feedback. It was hypothesised that dietary behaviours would be improved in the intervention groups compared with the control group after 9 months of intervention. Additionally, it was hypothesised that involvement of the parents would increase the effectiveness of the intervention.

Methods

Subjects

The present study was a clustered randomised controlled trial. Because of the higher prevalence of overweight and obesity in schools offering technical or vocational training, a random sample of 15 schools out of the 65 schools with technical and vocational education in West-Flanders (Belgium) was selected to participate in this study. The 15 schools were randomly assigned to the intervention or control conditions: intervention with parental support ($n = 5$, 1226 pupils), intervention alone ($n = 5$, 1006 pupils) and a control condition ($n = 5$, 759 pupils). The parents of all 2991 pupils in the 7th and 8th grades received an informed consent in which authorisation was enquired for their child to complete measurements. The parents of 151 (5%) children did not give permission for their child to participate in the study. This resulted in a sample of 2840 boys and girls aged 11–15 years within 15 schools. Table 1 presents the baseline data of the sample according to condition. The study protocol was approved by the Ethical Committee of Ghent University.

Measurements

Measures were assessed at the beginning (September 2003) and repeated at the end of the school year (June 2004).

Fat intake was measured with a self-administered questionnaire developed at Ghent University together with the Flemish Institute for Public Health²⁸. The questionnaire was validated in a separate study and was found to be sufficiently reliable and valid compared with a dietary record method²⁸. The questionnaire consisted of 48 items representing all important sources of fat in the Belgian diet. Pupils were asked how often they consumed these products during a usual day, week or month. A coefficient was calculated, representing the fat content and portion size of each product. This coefficient was multiplied by the frequency of consumption, leading to a fat intake score for each food item. The summation of fat intake scores for all food items led to the total fat intake score²⁷. Individual recommended energy intake was calculated from standard recommended energy intake tables based on height, weight, sex, age and activity level^{29–32}. This allowed expression of the reported fat intake as a percentage of the total energy intake.

Table 1 Demographics at baseline in the total group and the three conditions

	Total group ($n = 2840$)	I + P ($n = 1226$)	I ($n = 1006$)	C ($n = 759$)
Age (years), mean \pm SD	13.1 \pm 0.81	13.04 \pm 0.79	13.24 \pm 0.87	12.85 \pm 0.71
% of girls	36.6	40.1	15.6	58.8
% lower SES	67.5	68.0	78.9	52.4

I + P – intervention with parental support; I – intervention alone; C – control group; SD – standard deviation; SES – socio-economic status.

The percentage of children exceeding the fat intake recommendation of a maximum of 30% energy from fat was calculated³².

A validated food-frequency questionnaire³³, adapted from the questionnaire used in the HBSC study (Health Behaviour in School-aged Children), was used to assess fruit intake. The question for fruit intake was: 'How many pieces of fresh fruit do you usually eat?' The percentage of children not meeting fruit intake recommendations (2 pieces a day) was calculated. A separate food-frequency questionnaire was used to assess the consumption of soft drinks and water. The questions asked for soft drinks were: 'How many glasses of soft drinks do you drink during a regular school day?' and 'How many glasses of soft drinks do you drink during a regular weekend day?' The same questions were repeated for water.

Demographic factors, i.e. birth date, gender, occupation of father and mother, number of computers at home, were assessed using another self-administered questionnaire. An estimate of socio-economic status of the family was obtained by classifying occupation of the father and mother according to the 'white collar' and 'blue collar' method³⁴.

All questionnaires were filled out at school during class hours and under direct supervision of the teachers. At baseline 166 children did not fill out the fruit intake questionnaire, 182 children did not fill out the questionnaire for water and soft drinks consumption and 203 did not fill out the fat intake questionnaire, due to being absent on the day of measurement or changing schools. There were 176 fruit intake questionnaires, 162 water and soft drinks intake questionnaires and 74 fat intake questionnaires missing at the 1-year post-intervention measurements.

The intervention

The school-based intervention programme was developed to promote healthy food choices and physical activity engagement in order to prevent the increasing prevalence of overweight in children. The intervention was implemented over one school year, beginning in October 2003 and ending in June 2004. Only the healthy food intervention is described below. The effects of the intervention on adiposity indices³⁵ and children's physical activity levels (submitted) are reported elsewhere.

Working group

The healthy food intervention was designed for implementation by the school staff itself. Therefore a working group was composed of the principal, the physical education teacher(s) and other involved teachers. The working group received background information and guidelines on how to address the intervention topics. They received an intervention manual and educational material. Every three months a 1-h meeting with the working group

and the research team was held to evaluate the implementation and to plan further actions.

Nutrition interventions

The food intervention focused on three behavioural changes that were supported by environmental changes: (1) increasing fruit consumption to at least 2 pieces a day; (2) reducing soft drinks consumption and increasing water consumption; and (3) reducing fat intake. Environmental strategies were aimed at increasing the availability of healthy food products and decreasing the availability of unhealthy food items at school. Hence, policies concerning the availability of unhealthy and healthy food products in 7th and 8th graders were tackled.

The number of Flemish secondary schools offering fresh fruit is limited, and it is not convenient for adolescents to take fruit with them from home to school¹⁷. Therefore, to facilitate fruit consumption, fruit was sold once a week at school at low cost or provided free to all 7th and 8th graders. It was also suggested to offer fruit as a dessert of the school lunch. Most of Flemish secondary schools have stores or vending machines selling soft drinks. Hence, soft drinks are often consumed during breaks and at noon. In addition, soft drinks are often available as a part of the school lunches. Since pupils are more likely to consume soft drinks every day if soft drinks are available at school¹⁷, the intervention aimed to change the availability and accessibility of soft drinks. Furthermore, schools tried to promote the drinking of water as opposed to soft drinks, by offering it free by means of drinking fountains or at a lower price than soft drinks in shops or vending machines.

Children received information about the improved health consequences of eating fruit as opposed to snacks and drinking water rather than soft drinks. During classes children received the computer-tailored intervention for fat intake²² and fruit intake. Questionnaires concerning demographics, food intake and psychosocial determinants of food choices led to a tailored fat and fruit advice. After completing the questionnaire tailored feedback was displayed immediately on the screen. Both the fat and the fruit advice started with a general introduction, followed by normative feedback, which related their intakes to the recommended intakes. The fat advice indicated the sources of fat in the diet and tips were given on how to replace fatty foods. The Transtheoretical Model³⁶ was used to define the content and approach of the feedback in the fat advice. Based on the theory of planned behaviour³⁷, children received tailored feedback about their intentions, attitudes, self-efficacy, social support, knowledge, benefits and barriers related to their fat intake. In the same way as in the fat advice, the approach of the fruit advice was also based on the Transtheoretical Model. Overall a healthy diet was promoted in an advice of about 5 to 6 pages. Children could either save the advice on the computer or in some

cases immediately print the feedback. Afterwards they had to complete a task with questions concerning their advice.

Teachers were also encouraged to organise activities like healthy breakfast and educational games, as suggested in the intervention manual. In addition schools were encouraged to develop extra activities supportive to the intervention programme.

Parental involvement

The goal of the parent involvement was to also create a supportive environment for healthy behaviours away from school. An invitation for an interactive meeting on food habits and the relationship with health was sent to all parents. It is known that parental involvement declines as children move from elementary school through middle school^{38,39} and it is often difficult to get parents to participate in meetings at school⁴⁰. Hence, in order to reach all parents, the information was also communicated in the school paper and newsletters for the parents and was sent to their home address. In these materials parents were made aware of their important role in influencing their children's dietary behaviours.

Most children (97%) reported to have one or more computers at home. Hence, a CD with the adult computer-tailored intervention for fat intake²² was given to all parents to use and complete at home. Parents were thus made aware of their own fat intake and its consequences for health. The advice gave personalised information on how to make changes towards a more healthy diet. Through a brochure parents were informed that their child also used a similar computer-tailored tool, at school in class. They were asked to discuss the feedback that they both received together and to support their child in making the healthy changes suggested in the feedback.

Statistical analyses

Data were analysed using SPSS 12.0 (SPSS Inc.). Preliminary analyses consisted of descriptive statistics of sample characteristics. Linear mixed models on 1-year post-intervention measures were used to test intervention effects of the school-based healthy diet promotion intervention. Condition and gender were entered as factors in the model. School was nested within condition to take into account school variance. All analyses were adjusted for baseline values, age and socio-economic status. Pre–post analyses on percentage of energy from fat were also adjusted for pre–post differences in physical activity levels since these differences could have caused differences in energy requirements between intervention and control groups. *Post hoc* analyses were conducted to determine the direction of differences between the conditions. A *P*-value of <0.05 was considered statistically significant.

Results

At baseline on average 69% of the children exceeded fat intake recommendations and on average 85% did not meet fruit intake recommendations. Children reported to drink on average 3 glasses of soft drinks each day.

The pre- and post-intervention values of self-reported fat intake, fruit consumption and soft drinks and water consumption are presented in Table 2. The intervention was not effective in increasing self-reported fruit intake and water consumption and no positive intervention effects on soft drinks consumption were found. There was a trend for a significant condition by gender interaction effect for fat intake and percentage of energy from fat. For these variables, the intervention was effective in girls, but not in boys. Table 3 presents pre- and post-test intake levels and *F*-values of the *post hoc* analyses in girls. *Post hoc* tests revealed that fat intake and percentage of energy intake from fat decreased significantly more in girls of the intervention with parental support group, compared with both other conditions.

Discussion

There is ample evidence that children and adolescents in the USA as well as Europe have poor dietary habits^{2–4}. The baseline data of the present study clearly confirm these findings for a Belgium-Flanders sample. At baseline very high percentages of boys and girls did not meet fat and fruit intake recommendations and soft drinks consumption was very high. Such dietary habits are putting adolescents at greater risk for chronic problems in adulthood^{41,42}. Since food habits are likely to deteriorate further in adolescence^{9,43}, there is an urgent need for effective interventions aimed at influencing and improving dietary habits in these youngsters. The present study is therefore somewhat promising, since it showed that a well-planned, theory-based intervention combining personal and environmental change strategies induced some positive dietary changes in girls.

Flemish secondary schools offer a wide range of low-nutritive food items in their shops and vending machines¹⁷. Earlier research pointed out that this unhealthy school environment has a significant negative influence on adolescents' eating behaviour¹⁷. However, previous intervention studies in middle schools^{25,26} revealed that environmental changes alone were not sufficient to change adolescents' food behaviour and that interventions have more success if personal and environmental factors are targeted⁴⁴. The present intervention was unique in combining computer-tailored feedback with environmental changes for the first time. The intervention had positive effects on fat-related outcomes in girls, but only when parental support was included. Notice there were positive intervention effects only for fat and that this was the behaviour targeted by environmental change as

Table 2 Pre- and post-intake levels (mean \pm SD) and F -values for effects of a healthy diet intervention

Condition		Pre	Post	$F_{\text{Condition}}$	$F_{\text{Condition} \times \text{gender}}$	$F_{\text{Condition}}$	
						Boys	Girls
Fat intake (g day ⁻¹)	I + P	111 \pm 48	105 \pm 49	1.3	2.4(*)	1.4	9.3***
	I	130 \pm 54	127 \pm 56				
	C	108 \pm 46	104 \pm 45				
% energy from fat	I + P	38.7 \pm 16.3	35.1 \pm 16.1	1.4	2.4(*)	0.7	9.0***
	I	43.7 \pm 18.1	40.2 \pm 17.8				
	C	39.4 \pm 16.2	36.7 \pm 15.7				
% > fat recommendations	I + P	65.5 \pm 47.6	54.2 \pm 49.9	2.8	1.5	NA	
	I	74.1 \pm 43.8	66.4 \pm 47.3				
	C	67.7 \pm 46.8	61.0 \pm 48.8				
Fruit intake (pieces week ⁻¹)	I + P	5.3 \pm 5.3	5.4 \pm 5.3	0.2	1.1	NA	
	I	4.6 \pm 5.0	4.4 \pm 4.7				
	C	6.5 \pm 5.0	6.0 \pm 4.9				
% < fruit recommendations	I + P	85.8 \pm 34.9	84.3 \pm 36.4	0.5	0.78	NA	
	I	88.0 \pm 32.5	89.3 \pm 30.9				
	C	80.3 \pm 39.8	82.1 \pm 38.3				
Soft drinks (glasses day ⁻¹)	I + P	3.1 \pm 2.4	3.1 \pm 2.5	2.6	0.9	NA	
	I	3.5 \pm 2.5	3.9 \pm 2.8				
	C	2.5 \pm 2.2	2.6 \pm 2.4				
Water (glasses day ⁻¹)	I + P	3.4 \pm 2.7	3.7 \pm 2.8	0.3	0.3	NA	
	I	3.1 \pm 2.7	3.5 \pm 2.9				
	C	3.7 \pm 2.6	4.0 \pm 2.8				

SD – standard deviation; I + P – intervention with parental support ($n = 1055$); I – intervention alone ($n = 685$); C – control group ($n = 655$); NA – not applicable because $F_{\text{Condition} \times \text{gender}}$ was not significant.
(*) $P < 0.09$; ***, $P < 0.001$.

well as computer tailoring for both adolescents and parents.

Results from the Planet Health study²⁷ after 2 years of intervention indicated that fruit intake increased on average by 0.2 servings a day in girls of the intervention group, while it decreased on average by 0.2 servings a day in the control group. In the present study no positive intervention effects on fruit intake were found. However, it could be argued that a longer intervention period may be necessary to assess significant positive effects, since after 9 months in the present study fruit intake increased by 0.1 servings a week in the intervention with parental support group, while it decreased by 0.5 servings a week in the control group. Declines in fruit intake, as found in the control group, could be due to seasonal variation in availability of fruit when comparing September to June intakes.

Neither in boys nor in girls were there positive intervention effects for soft drinks and water consumption. These findings strengthen our assumption that the

combination of a personalised intervention with environmental changes and parental support is essential to access positive intervention effects. The lack of personalised tailored feedback for soft drinks and water consumption could have resulted in an insufficiently intensive intervention for these specific behaviours. Additionally, our experiences were in line with previous research in Flemish secondary schools revealing that financial interests are making school boards resistant to eliminate or reduce the sale of soft drinks during breaks or at lunch¹⁷. The increasing consumption of sugar-sweetened drinks is considered to contribute to the increasing prevalence of overweight and obesity¹³. Therefore research evaluating the effects of combining personalised interventions with environmental changes on soft drinks and water consumption should be a priority. Furthermore, the huge incomes secondary schools receive from shops and vending machines result in school boards neglecting the importance of a healthy school environment. Therefore

Table 3 Pre- and post-test intake levels (mean \pm SD) and F -values and *post hoc* test indicators for intervention effects on fat intake and % energy from fat in girls

Condition		Pre	Post	<i>Post hoc</i>	F_{Posthoc}
Fat intake (g day ⁻¹)	I + P	97 \pm 38	85 \pm 35	I = C	0.5
	I	108 \pm 46	98 \pm 40	I + P > I	6.1*
	C	99 \pm 39	95 \pm 40	I + P > C	17.3***
% energy from fat	I + P	37.5 \pm 15.0	31.9 \pm 13.6	I = C	1.0
	I	41.1 \pm 16.8	36.6 \pm 15.2	I + P > I	3.9*
	C	38.7 \pm 15.8	36.1 \pm 15.5	I + P > C	16.7***

SD – standard deviation; I + P – intervention with parental support ($n = 432$); I – intervention alone ($n = 108$); C – control group ($n = 392$).
*, $P < 0.05$; ***, $P < 0.001$.

one possibility is the restriction of low-nutritive food at school by governmental laws. However, only limited research exists showing that restricting the sale of soft drinks in schools would improve dietary habits in youth⁴⁵. It is possible that adolescents would compensate for the lack of soft drinks at school by the consumption of other sweetened products or by drinking more soft drinks outside school⁴⁵.

In the present study there were clear gender differences in the results. The intervention was effective only in girls and not in boys. These gender differences are in line with the findings from the Planet Health study²⁷. In that study²⁷ a health education programme was used and limited effects on total energy from fat were found only in girls. Previous research revealed that adult women compared with men were more positive towards the computer-tailored intervention for fat intake⁴⁶. It is probable that girls were more responsive to the messages of the tailored intervention since in general girls are more attuned to issues of diet⁴⁷. This indicates that combining changes in the school environment with personalised tailored feedback and increasing parental support is the most promising intervention strategy to address fat intake in adolescent girls. However, more research needs to be done on how to address boys.

Strengths of the present study are the clustered randomised design with a high participation rate and the combination of a new intervention type, namely a computerised tailored intervention, with environmental changes, which was used for the first time in adolescents. A limitation of the present study is the self-reported character of the measurements. Self-reported measures used to assess dietary intakes of adolescents tend to result in reporting errors⁴⁸ and limited data are available to understand the reporting bias in this age group. Therefore the data in the present study should be treated with considerable caution. In the present study the effect of the whole school intervention was evaluated, while it is also important to study the effects of each component. No studies are available to date that document the effects of personalised tailored food interventions in adolescents. Additional priorities for future research include improving dietary interventions for boys and assessing long-term intervention effects in boys and girls.

In conclusion, the present study provided evidence that the use of school environmental changes to increase the availability of healthy foods at school, together with the use of tailored interventions to motivate and enable healthy choices in girls and their parents, can have positive effects on girls' diets.

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