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Implemented or not implemented? Process evaluation of the school-based obesity prevention program DOiT and associations with program effectiveness

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Abstract

This study investigates if and to what extent the Dutch Obesity Intervention in Teenagers (DOiT) program was implemented as intended and how this affected program effectiveness. We collected data at 20 prevocational education schools in the Netherlands. We assessed seven process indicators: recruitment, reach, dosage, fidelity, satisfaction, effectiveness and continuation. Data collection involved teacher questionnaires ($n = 110$), adolescent questionnaires and adiposity measures ($n = 938$). Using multi-level confirmatory factor analyses, we applied an innovative method to obtain explorative implementation index scores. The percentage of accomplished activities ranged from 9% (for 'closure meeting') up to 93% (for 'obtaining support within the school for adoption'). The percentage of lessons delivered decreased from 74 to 18% towards the end of the program. Fidelity to the teacher manual ranged from 85 to 26%. In general, teachers were satisfied with the DOiT lessons and teaching materials. Despite teachers' satisfaction with the DOiT lessons and teaching materials, degree of program implementation was lower than expected, especially towards the end of the program. Further, some evidence was found for an association between a higher implementation index score and program effectiveness, but more research is needed to test the validity of the implementation index.

Introduction

Numerous research activities are focused on developing and evaluating evidence-based obesity prevention programs to combat the major public health problem of childhood obesity [1, 2]. Schools are regarded as a convenient and practical setting to implement obesity prevention programs that target students' energy balance-related behaviors (EBRBs) [1]. Many of these school programs consist of multiple interacting components and are, therefore, complex to implement and evaluate. Randomized-controlled trials (RCTs) of such programs are often criticized as being a 'black box', since it can be difficult to know why (or why not) the program worked without examining underlying processes [3]. With the public health impact of these programs depending on their implementation in practice, it is important to understand if and to what extent a program was implemented as intended and how this affected program effectiveness.

The Dutch Obesity Intervention in Teenagers (DOiT) program is an example of such a school-based program that showed promising results during an RCT on measures of adiposity [i.e. thinner skinfold thickness in boys and girls, and smaller

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waist circumference (WC) in boys], and EBRBs [i.e. a reduction in sugar-containing beverage (SCB) consumption in both boys and girls, and a reduction in screen time in boys] [4, 5]. Next, the initial program was adapted based on results of the concurrent process evaluation of the RCT and additional interviews with teachers, adolescents and parents [6].

From 2011 onwards, the adapted program was available for further dissemination and is currently being implemented at schools throughout the Netherlands. The effectiveness of this process of adoption, implementation and continuation was also evaluated [7]. This evaluation indicated that the adapted DOiT program showed only modest intervention effects on behavior: a decrease in consumption of SCB in girls (−188 ml/d) and an increase in breakfast frequency in boys (+0.29 days/week), but no effects on adiposity measures [8]. No mediating effects of the assessed EBRBs on adiposity measures were found [8].

Since the adapted DOiT program showed only modest intervention effects on behavior, it is important to gain insight into the 'black box' of processes underlying the programs effects. Therefore, the aim of this study was to evaluate the implementation process of DOiT during nationwide dissemination. The objectives of this study were to assess the degree of implementation during dissemination, based on process indicators (i.e. recruitment, reach, dosage, fidelity, satisfaction, effectiveness and continuation) and to explore the association between the degree of implementation and changes in adolescents' adiposity measures and EBRBs.

Methods

We conducted an implementation evaluation study that systematically monitored and evaluated dissemination of DOiT at 20 implementing schools in the Netherlands. As part of this implementation study, a cluster-controlled study was conducted with nine control schools to evaluate the effectiveness of implementation of DOiT on adolescents' adiposity and EBRBs. The program's protocol [7], and effectiveness [8] have been published elsewhere. The Medical Ethical Committee of the VU University Medical Center approved the study protocol in which we applied a passive consent procedure for adolescents.

Program

DOiT is a school-based obesity prevention program for 12- to 14-year-olds, developed according to the Intervention Mapping protocol [6, 9, 10]. The program targets both sides of the energy balance equation (energy intake and energy expenditure) in order to prevent overweight and obesity in adolescents. The initial program was developed and evaluated in 2002–2006 [4, 5, 9, 11]. In 2009, the program was adapted, consisting of 12 fixed theory lessons and four physical education (PE) lessons (i.e. 16 lessons equally divided over 2 school years), three optional lessons and a parental component. The lessons in the first year aimed at increasing awareness and knowledge of EBRBs and to induce behavioral changes concerning EBRBs in order to prevent obesity in adolescents. The lessons in the second year focussed on increasing awareness and coping mechanisms for the influence of the (obesogenic) environment [9]. The parental component focused on increasing social support of the parents and on raising awareness of the availability and accessibility of healthy products and activities in the home environment [9].

The DOiT materials included a 'schoolbook' accompanied by worksheets, a student toolkit (pedometer, food/exercise diary and online computer-tailored advice) and a parental information booklet. Two versions of the program were developed tailored to the levels of the prevocational education system in the Netherlands [12]. The implementation of DOiT was supported by an extensive teacher manual with a login for extra materials provided at the DOiT website. Table I provides an overview of the DOiT lessons and the core activities of DOiT.

To facilitate the implementation process, a seven-step implementation strategy was developed with accompanying materials for teachers, published on the DOiT website (Table II) [13]. Via the website, we provided a toolkit for implementation containing

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Table I. *Description of the class room activities of the DOiT program, satisfaction by teachers and delivery according to the teacher manual*

	Lesson delivered ($n = 57$)	Mean (SD) satisfaction[a]	Core activity delivered ($n = 44$)	Implementation according to teacher manual
First six theory lessons to be delivered in the first year				
1. 'Healthy nutrition'	**74%**	6.6 (2.1)		
Assessment of general health knowledge			66%	69% (20/29)
Explore contents of fridge at home			66%	62% (18/29)
2. 'Eating moments'	**70%**	6.8 (2.2)		
Assignment about daily breakfast consumption			46%	75% (15/20)
Daily recommendation for food and drink intake			77%	61% (20/33)
Reading food and drink labels			63%	63% (17/27)
Complete diary on dietary behavior			52%	57% (13/23)
3. 'Enough exercise'	**63%**	6.6 (2.2)		
Daily recommendations for physical activity			86%	47% (18/38)
Physical activity test			61%	74% (20/27)
Manual measurement of heart rate			64%	61% (17/28)
Using pedometer to measure PA			43%	79% (15/19)
Complete diary on PA behavior			41%	67% (12/18)
4. 'Energy balance'	**47%**	6.3 (2.1)		
Calculated energy balance using completed food and PA diary			36%	63% (10/16)
Calorie calculation			55%	50% (12/24)
Online computer-tailored advice			30%	85% (11/13)
5. 'Change behavior'	**54%**	6.6 (1.8)		
Set a personal goal for behavioral change for one of the five targeted EBRBs			50%	50% (11/22)
Assignment to test knowledge about soft drinks			43%	68% (13/19)
Interview with parents about diet and PA habits			34%	53% (8/15)
6. 'Maintain your goal'	**40%**	6.2 (1.8)		
Discuss excuses for not maintaining healthy behavior			59%	54% (14/26)
Support of parents and peers to maintain healthy behavior			59%	42% (11/26)
Conclude year 1 with 'knowledge quiz'			27%	50% (6/12)
Second six theory lessons to be delivered in the second year				
7. 'Food availability at school'	**56%**	6.6 (1.7)		
Evaluate if adolescents maintained their goal for healthy behavior			43%	32% (6/19)
Explore the school canteen			27%	42% (5/12)
Discuss healthy lunch options			39%	59% (10/17)
8. 'Advertisements'	**53%**	6.7 (2.0)		
Discuss influence of parents and peers to maintain healthy behavior			66%	31% (9/29)
Discuss commercial logo's to promote a healthy diet			52%	35% (8/23)
Supermarket movie tricks			57%	72% (18/25)
Discuss the effect of surreptitious advertising			66%	59% (17/29)
9. 'Diet and PA habits'	**39%**	6.2 (1.8)		
Discuss habits			48%	62% (13/21)
Start small research about influence of the environment			34%	67% (10/15)
10. 'Difficult moments'	**32%**	6.3 (1.4)		
Discuss how to cope with difficult moments			59%	46% (12/26)
Execute small research about influence of the environment			34%	53% (8/15)
11. 'Keep on DOiT'	**25%**	5.9 (1.7)		
Discuss the theme of 'confidence'			52%	26% (6/23)

(continued)

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Table I. *Continued*

	Lesson delivered ($n = 57$)	Mean (SD) satisfaction[a]	Core activity delivered ($n = 44$)	Implementation according to teacher manual
12. 'You DID iT!'	**18%**	6.4 (1.1)		
Present results of small research about influence of the environment			27%	33% (4/12)
Optional in-depth lessons				
1. DOiT 'Cooking'	**16%**	8.0 (1.4)		
2. DOiT 'Taste lesson'	**12%**	6.6 (1.3)		
3. DOiT 'Cultures'	**9%**	7.3 (1.9)		
First two PE lessons theory lessons to be delivered in the first year				
	($n = 35$)		**($n = 26$)**	
1. 'Pedometer'	**77%**	7.1 (1.4)	77%	80% (16/20)
2. 'Heart rate measurement'	**94%**	7.6 (0.8)	96%	52% (13/25)
Second two PE lessons theory lessons to be delivered in the first year				
3. 'Repeated heart rate measurement'	**60%**	7.2 (1.7)	—	—
4. 'My sport club'	**46%**	6.4 (2.4)	50%	31% (4/13)

PE, physical education; PA, physical activity; EBRBs, energy balance-related behavior.
[a]Measured on 10-point rating scale by delivering teachers.

materials for each implementation step to facilitate the adoption, implementation and continuation process and an online platform for exchange of experiences with program delivery. Furthermore, a 'DOiT support office' was available for support and advice for implementers of DOiT throughout the school year. The development and content of DOiT are described in more detail elsewhere [6, 9].

Dissemination

At the time of study, the adapted DOiT program was available for implementation to all schools in the Netherlands. The DOiT support office employee actively recruited schools by activities such as posting news items on relevant websites, digital mailings and being present at local meetings of relevant stakeholders [6]. Furthermore, the DOiT support office employee actively informed health promotion professionals at local supporting organizations, such as employees at municipalities, municipal health services or sport organizations, about the availability of DOiT.

Data collection

Data collection took place between September 2011 and June 2013. After a school had purchased the DOiT materials (i.e. 7 € per adolescent for the 2-year program), the school was invited to participate in this study, until a sample of 20 volunteering schools was reached. If a school agreed to participate, they were offered free materials for three classes and a short report of the research results upon completion, in exchange for their participation. We invited all teachers and adolescents of the three classes nominated by the school to participate in the evaluation study; no exclusion criteria were set. Data collection involved teacher questionnaires, and adolescents' self-reported EBRBs and adiposity measures.

Teachers

At baseline (T0), after eight (T1) and 20 months (T2), all teachers involved in the implementation of DOiT were asked to complete a questionnaire. At T0, all teachers completed the questionnaire on paper. At T1, teachers could either complete the questionnaire on paper or online. At T2, all teachers completed the questionnaire online.

The questionnaire was based on existing questionnaires, used in the previous DOiT evaluation [11] and a comparable study evaluating the dissemination process of a Dutch healthy diet program [14]. New items were constructed given the lack

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Table II. *Implementation strategy and activities for dissemination of DOiT as delivered by schools*

	Implementation strategy	Activities	Accomplished activities $n = 68$ teachers
Adoption	Step 1. Teacher reviewed the DOiT program	Used DOiT information materials; DOiT factsheet, brochure, website, promotional video	90% (61/68)
		Used exemplary teaching materials	40% (27/68)
	Step 2. Teacher identified barriers for implementation, identified solutions and gained support within the school	Presented information about DOiT to colleagues and school management	84% (57/68)
		Gained support within school	93% (63/68)
Implementation	Step 3. Teacher decided to work with DOiT and developed a tailored plan for implementation	Developed a plan for implementation	78% (53/68)
	Step 4. Teacher became familiar with the implementation of the program	Informed other colleagues about the DOiT	28% (19/68)
		Gained media attention for the start of program	22% (15/68)
		Used instructional video and teacher manual during preparation	75% (51/68)
	Step 5. Teacher delivered the program	Organized a kick-off meeting	21% (14/68)
		Used the teacher manual during implementation	85% (58/68)
		Used the login at the DOiT website during implementation	72% (49/68)
		Had regular contact with other implementing teachers	78% (53/68)
Continuation	Step 6. Teacher concluded and evaluated the program	Organized a closure meeting	9% (6/68)
	Step 7. Teacher defined impeding and facilitating factors for implementation and created a renewed plan for implementation and embedding of the DOiT program in the school	Organized an evaluation with involved teachers	54% (37/68)
		Developed a plan for continuation of DOiT at school	46% (31/68)

of available questionnaires in the literature for some process indicators. The questionnaire addressed seven process indicators: recruitment, reach, dosage, fidelity, satisfaction, effectiveness [15–19]. At T0, mainly questions addressing recruitment and context of the school were asked. At T1 and T2 reach, dosage, fidelity, satisfaction and effectiveness were administered.

'Recruitment' was defined as methods used to recruit schools, the number of recruited schools and the decision making process at schools preceding the start of the program.

'Reach' was defined as the number of teachers and adolescents involved in (evaluating) the implementation of DOiT.

'Dosage' refers to the mode of program delivery by teachers, the amount of delivered DOiT lessons and the implementation strategy activities that were accomplished. Teachers could indicate which lessons (yes/no), core activities (yes/no) they had delivered and which activities directed at parents they had conducted. Regarding the implementation strategy, teachers could indicate which core activities they had conducted (yes/no/don't know).

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'Fidelity' refers to the extent to which the program was delivered according to the teacher manual. Every teacher could indicate per core activity if they had executed the activity according to the teacher manual or if they had adapted the respective lesson.

Teachers rated their 'satisfaction' with the DOiT lessons, teaching materials and teacher manual on a 10-point rating scale. Teachers also rated their satisfaction with feasibility of the program and specific aspects of the teacher manual on a five-point Likert scale.

On a five-point Likert scale, we asked teachers if they regarded the program as 'effective' for adolescents to: obtain new knowledge on EBRBs, become more awareness of their unhealthy behaviors, change their EBRBs, and maintain their new behaviors.

'Continuation' refers to the extent to which DOiT became part of the curriculum and school policy. Teachers indicated (yes/no) if they had the intention to use DOiT in the next school year, if they thought the program was suitable for other schools, and if they would recommend the program to other schools. Regarding embedment, teachers indicated whether the program was embedded in the curriculum of the school and in the school health policy.

Further, quality of delivery was assessed [20] by having teachers rate their knowledge, skills and self-efficacy to deliver the program, and their experienced support for implementation (i.e. by their colleagues, supervisor, DOiT coordinator and DOiT office) in the T2 questionnaire.

Adolescents

Before the start of DOiT (T0) and after 20 months (T2), adolescents' adiposity was measured and self-reported information on EBRBs was obtained. We objectively measured body weight and height, skinfold thickness and WC.

The EBRBs questionnaire addressed six behaviors: consumption of SCB, high-energy snacks/sweets and breakfast, screen time (TV viewing and computer use), active transport to school and sport participation. Frequency and quantity of the reported behaviors were multiplied to obtain estimates of mean daily behavior. Self-reported values exceeding the 95th percentile of the respective sample distributions were treated as outliers and replaced by the values representing the 95th percentile of the distribution. Details on the measurements have been described elsewhere [7].

At the final measurement (T2), adolescents' satisfaction with the DOiT materials was assessed on a 10-point rating scale.

Analyses

Descriptive statistics (mean, SDs and proportions) were computed to obtain baseline characteristics of the schools and adolescents. Due to the skewed distributions of data of five-point Likert scales questions, answers were dichotomized into 'agree' and 'neutral/disagree'.

Linking implementation to program outcomes

Because a systematic tool that combined different process measures into a single implementation index score was lacking, we developed an implementation index for DOiT.

The index initially included 44 relevant implementation-related items. Item selection was theory-driven, i.e. the selected items were considered to contribute to a higher degree of implementation based on the systematic development of DOiT and the supporting implementation strategy [6, 9]. Items were distributed over different factors, based on recommendations of Domitrovich *et al.* [20] and the implementation index of Dix *et al.* [21] (Table III). It was expected that at T2 (i.e. at 20-month follow-up) a reasonable degree of implementation would have been achieved and teachers were, therefore, asked to report on these items during the T2 questionnaire.

First the validity of each of the eight factors was tested separately and then the validity of the eight-factor structure in one overall construct, by conducting multi-level confirmatory factor analysis in Mplus [22, 23]. Goodness-of-fit indices (i.e. Root Mean Square Error of Approximation < 0.05, Standardized Root Mean Square residual < 0.05, Comparative Fit Index > 0.95 and Chi-Square

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Table III. *Items included in DOiT implementation index*

Level	Fidelity (16 items)	Dosage (9 items)	Quality of delivery (8 items)
Intervention (teacher)	**Core elements program** Year 1 (seven items) Year 2 (three items) PE lessons (one item)	**Occurrence of program** Frequency (three items)	**Teacher implementation-related determinants** Knowledge Motivation Skills‘ Self-efficacy (four items)
Support system	**Core elements implementation strategy** (five items)	**Occurrence of support activities** (six items)	**Organization implementation-related determinants** Support (four items)

$P < 0.05$) were assessed and compared, as well as modification indices for optimizing models. Models were accepted with adequate-to-good fit and items deleted with non-significant loadings [22]. The final DOiT implementation index consisted of 33 items divided over the eight factors (Table III) with an index score ranging from 8 to 31 (with higher scores corresponding to higher degree of implementation).

As theory teachers could not answer PE lesson delivery questions and vice versa, individual missing values were replaced by the school's respective median. Standardized coefficient scores were subsequently used to calculate one final implementation index score for each teacher. Due to teacher and student turnover during 2-year implementation, teacher implementation data could not be linked with adolescent data. Therefore, we aggregated data at school level. As there were overall small variations in implementation index scores between teachers within one school, school implementation index scores were calculated as the mean teacher score at that school. Due to non-normal distribution, the school implementation index scores were recoded into tertiles: i.e. 'low' (0), 'medium' (1) and 'high' (2).

Associations were explored between school implementation index scores (low/medium/high) and changes in EBRBs and adiposity measures using multi-level linear regression analysis in MLwiN 2.22. Three levels were defined in our multi-level analyses: (i) adolescent, (ii) class and (iii) school. Analyses were adjusted for baseline values, age, gender, ethnicity and educational level. For all analyses $P < 0.05$ was regarded as statistically significant.

Results

Recruitment

Recruitment of schools took place from January 2011 to December 2011. In total, 628 contacts (i.e. teachers and professionals such as intermediaries at municipalities, municipal health services or sport organizations) were approached by email and/or mail. Because of the nature of the program rollout, the denominator (i.e. how many schools were approached in total) is unknown. Overall, 66 schools ordered the DOiT materials within the first year. Twenty-six schools (39%) ordered the program themselves and 40 schools (61%) received the program via local supporting organizations (e.g. intermediaries ordered materials for the school). The first 20 schools enrolled in the study (implementation evaluation). Eleven of those 20 schools ordered extra DOiT materials on top of the free materials they received for participation in the study. The materials were financed from the general school budget ($n = 7$), the school sports budget ($n = 1$) or through municipal funding ($n = 3$).

Reach

More than 5000 adolescents received DOiT at these 66 implementing schools. At the 20 enrolled schools, 1459 adolescents and 118 teachers were reached. One school ($n = 61$ adolescents, three teachers) withdrew during the trial, due to lack of support from school management. A second school ($n = 64$ adolescents, five teachers) participated in

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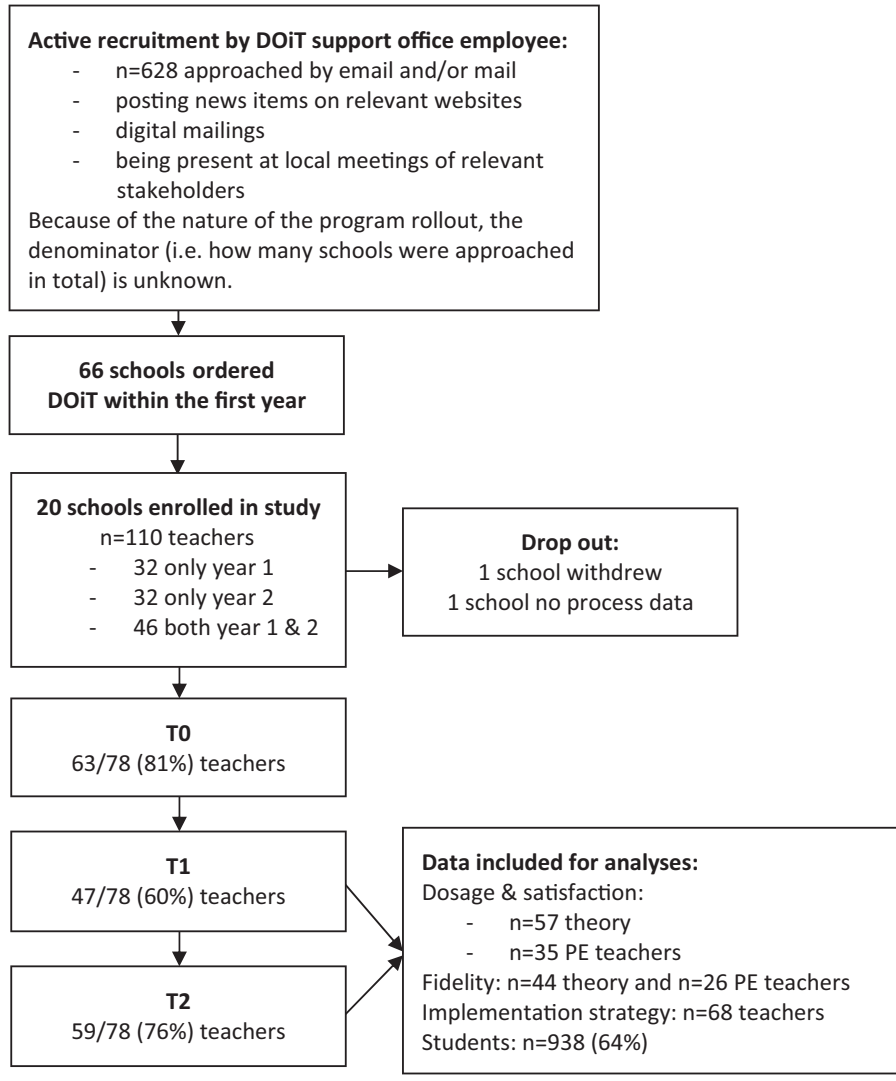

Fig. 1. Flow chart of the study. n = number of respondents; PE = physical education.

the effect evaluation only, but declined to provide teacher data. Therefore, data from 18 schools could be included for analyses.

Within these 18 schools, 110 teachers were involved in the implementation of the program; 32 teachers solely taught DOiT in year 1, 32 teachers solely taught DOiT in year 2 and 46 teachers taught DOiT in both school years. Baseline data were collected from 63 teachers (response rate 81%) and T1 follow-up data from 47 teachers (response rate 60%). The T2 questionnaire was completed by 68 teachers, of whom 59 (response rate 76%) implemented the program during the second year.

In total, 938 adolescents (64%) were included for analyses. Main reasons for drop-out were drop out of school and absence from school during the lesson when data collection took place. Figure 1 provides a flow chart of the study.

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Dosage

Two of the eighteen schools solely implemented the theory lessons, but not the PE lessons. Two schools only implemented the program in the first year, while another school only started implementation of the program in the second year, due to teacher turnover and logistical reasons.

More than half (61%) of the teachers reported that they implemented the program during a project week and in addition to the regular curriculum (55%). Sixty-eight percent of the theory teachers and 43% of the PE teachers reported that they had delivered the lessons in the order as described in the teaching manual.

On average teachers delivered 3.5 of six (58%) lessons in the first year and 2.2 of the second six (37%) lessons in the second year. PE teachers delivered on average 2.8 of the four (70%) planned lessons, spread over the 2 years. The percentage of delivery decreased towards the end of the program. Table I describes the percentage of delivered DOiT lessons and core activities.

Regarding the parental component, 22% of the teachers had distributed the parent information booklet; 27% had given adolescents some of the homework assignments that were supposed to involve parents; and 17% had provided information about DOiT to parents via the school newsletter.

Table II presents an overview of the implementation strategy activities that were accomplished as reported by the teachers.

Fidelity

Delivery according to the teacher manual ranged from 26% (discuss theme confidence) to 85% (theory lesson that used computer-tailored advice) (Table I). On average, 56% of the lessons were delivered according to the teacher manual.

Satisfaction

Tables I and IV describe the satisfaction with the DOiT lessons and materials as rated by teachers and adolescents. Overall, teachers were satisfied with the DOiT lessons and teaching materials. Adolescents were moderately satisfied with the DOiT materials.

The majority of teachers were positive about the match of DOiT with the adolescents' perception (85%); the assumed adolescents' education level (74%); and their regular teaching method (56%). Sixty-two percent of the teachers reported that the time investment for DOiT was feasible.

Teachers were also satisfied with the teacher manual: 82% liked the layout; 79% liked the structure; 67% thought the manual provided enough options for flexibility; and 78% found that the manual provided enough guidance to deliver the lessons.

Table IV. *Satisfaction with DOiT materials by teachers and adolescents*

DOiT materials	Teachers		Adolescents	
	n	Mean (SD)[a]	*n*	Mean (SD)[a]
Teacher manual	71	7.4 (1.0)		
Teacher login at DOiT website	36	7.4 (0.9)		
Adolescent text book	41	7.0 (1.0)	629	6.0 (1.8)
Adolescent worksheets	55	7.3 (1.2)	601	5.7 (1.8)
CHECKiT (pocket-sized diary)	26	6.7 (1.3)	562	5.4 (1.9)
Pedometer	66	6.7 (2.0)	629	6.8 (2.1)
Calorie guide	28	7.4 (1.2)	602	6.1 (2.1)
Supportive video material (supermarket)	23	7.6 (0.8)	447	6.3 (1.8)
Online computer-tailored advice	18	6.9 (0.8)	272	6.4 (1.7)
Information booklet for parents	18	7.7 (0.7)		

[a]Measured on 10-point rating scale by delivering teachers; n = number of respondents; SD, standard deviation.

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Table V. *Baseline school characteristics stratified for degree of implementation*

	Total Mean (SD) or %	Low implementation $n = 6$ schools Mean (SD) or %	Medium implementation $n = 6$ schools Mean (SD) or %	High implementation $n = 6$ schools Mean (SD) or %
School implementation index score	20.6 (2.3)	17.7 (0.9)	21.1 (0.4)	23.1 (0.7)
School size (number of adolescents)	763 (481)	685 (440)	955 (624)	626 (332)
Urbanization (% urban ≥20.000 inhabitants)	72%	83%	100%	33%
School has a health policy document (% yes)	33%	33%	33%	33%
Teachers involved in adoption decision (% yes)	51%	35%	41%	83%
Ethnicity (% Western)[a,b]	68%	41%	77%	85%
Education level (% high)[a,c]	51%	24%	62%	63%
Overweight/obese (%)[a,d]	23%	25%	21%	23%

[a]based on adolescents included in analyses.
[b]Education categories based on low (i.e. middle-management and basic vocational track) and high (i.e. theoretical and combined track) education according to the four sub tracks of prevocational education in the Netherlands (7).
[c]meaning both parents were born in a Western country.
[d]Weight categories based on the IOTF 2012 criteria, including both overweight and obesity [24].

Effectiveness

As reported elsewhere [8], the intervention showed only modest effects on EBRBs: a decrease in consumption of SCB in girls (−188 ml/d) and an increase in breakfast frequency in boys (+0.29 days/week), and no effects on adiposity measures. Furthermore, teachers reported that they thought adolescents: had gained new knowledge on healthy eating and physical activity as a result of DOiT (77%); had become self-aware of their behaviors (71%); had changed their behaviors (37%); had maintained their healthy behavior (14%).

Continuation

Forty-seven percent of the teachers reported that they wanted to continue DOiT after year 1; 33% after year 2. Most teachers thought DOiT was suitable for other prevocational education schools (90%). Forty percent of the teachers would recommend DOiT to other schools. Twenty-seven percent of the teachers reported that DOiT was embedded in their school curriculum and 19% reported that DOiT had become part of their school health policy.

Linking implementation to program outcomes

Table V describes the characteristics of low, medium and high implementing schools. Due to the small number of schools, differences were not tested for significance. School implementation index scores varied from 17 to 24.

Table VI describes the explorative association between degree of implementation and changes in adolescents' adiposity and EBRBs. Although the implementation index can only be considered exploratory, adolescents attending schools with a high implementation index score tended to have lower adiposity measures, while associations between implementation score and behavioral change were inconsistent.

Discussion

This process evaluation aimed to understand if and to what extent DOiT was implemented as intended and how this affected program effectiveness. Notably, insight into the implementation 'black

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Table VI. *Exploration of association between school implementation index score and intervention effect on adolescents' adiposity and EBRBs*

Measures of adiposity	Medium implementers[a] ($n = 417$ adolescents) B (95% CI)	High implementers[a] ($n = 236$ adolescents) B (95% CI)
BMI-z (WHO)[b]	0.01 (−0.06;0.09)	−0.08 (−0.17;0.01)
WC	−1.30 (−2.72;0.13)	−1.41 (−2.91;0.10)
Sum of skinfolds	0.66 (−2.51;3.84)	−1.64 (−5.24;1.97)
Measures of EBRBs		
SCB consumption (ml/d)	−63.03 (−250.94;124.88)	−12.24 (−223.00;198.53)
High energy snacks/sweets (portion/day)	0.02 (−0.41;0.46)	0.01 (−0.47;0.49)
Breakfast consumption (days/week)	−0.37 (−0.57;0.04)	**−0.36 (−0.71;-0.01)**
Screen time behavior (min/day)	7.34 (−32.47;47.14)	15.83 (−26.27;57.94)
Active transport to school (min/day)	**7.21 (0.20;14.21)**	1.68 (−6.18;9.53)
Sports participation (min/day)	0.16 (−7.27;7.59)	−1.23 (−9.71;7.25)

Adjusted for baseline values, age, gender, ethnicity and education.
[a]Reference category, low degree of implementation ($n = 285$ adolescents); bold, significant association ($P < 0.05$); B, regression coefficient; CI, confidence interval.
[b]Weight categories based on WHO (2007) criteria, including both overweight and obesity [25]; SCB, sugar-containing beverage.

box' of DOiT showed that implementation was not optimal: only half of the delivery was according to the teacher manual and implementation of lessons decreased over time. However, our exploratory analyses showed that adolescents attending schools with high implementation index scores tended to have more favorable adiposity measures. This is in line with previous studies which have demonstrated that completeness of implementation to be associated with improved program outcomes [26–28]. However, as adolescents cannot benefit from a program that is not or is only partly implemented, the decreasing level of program implementation might be an explanation for the overall modest or lack of intervention effects found [8].

There are several possible explanations for the decreasing level of program implementation in the present study: flexibility; teacher turnover; lack of support for implementation. The first explanation for the decreasing level of program implementation towards the end of the program is too much flexibility for program delivery. Due to the adaptations to the program, teachers were flexible in the delivery of the lessons. Only 56% of the delivered activities were implemented according to the teacher manual. One of the teachers' main critiques of the program was that its implementation required more time than expected. As a result, teachers might have prioritized activities that were easy to implement, such the guidelines for daily food intake (77% of teachers) and recommendations for daily physical activities (86%), compared with more complicated activities such as providing adolescents with computer-tailored personal advice to change their behavior (30%). Furthermore, the six theory lessons to be delivered in the second year were aimed at raising awareness of the unhealthy environment, finding solutions and setting a plan for improvement of the environment. During the final four lessons, adolescents participated in a small research project about their own environment. Because these lessons had the lowest percentage of delivery (39–18%), it might be that teachers did not like this teaching technique or could not fit those activities into their regular lessons. Although some studies have reported that teacher flexibility of delivery of educational and health programs can lead to higher levels of implementation and program outcomes [29], based on the results of this study this was not the case for the DOiT program.

The second possible explanation is teacher turnover. The fact that DOiT is divided over 2 school years requires—or it would at least be preferable—that teachers are teaching the same subject to the same classes in 2 subsequent years. In our study,

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only 42% of the teachers taught DOiT in both school years. Therefore, continued implementation during 2 years depended on sufficient knowledge transfer and communication between teachers. This could have failed during implementation.

Third, not all schools executed the implementation strategy activities according to plan. We supported teachers via an implementation strategy at the DOiT website and the availability of an employee posted at the DOiT support office. We developed the implementation strategy together with teachers and other school-based stakeholders; so all activities were expected to contribute to program delivery. Taking into account the decrease of implementation during the 2 years, this strategy appears not sufficient in supporting teachers during 2 school years of implementation. Earlier studies have shown that preintervention training is a common method to provide implementers with the required knowledge and skills (e.g. professional learning) for implementing a program (14, 20). Including at least one face-to-face instruction for coordinators and preferably also teachers instead of only a 5-min instructional video may be necessary for optimal implementation. Moreover, improvement of implementation support by active connection and communication between teachers (i.e. peer mentoring) could further improve program effectiveness.

Strengths and limitations

The main strength of this study is that we systematically monitored and evaluated the dissemination course at schools implementing DOiT, therefore, providing insight into the implementation 'black box' of DOiT. Another strength of this study is that we applied an innovative method to obtain school implementation scores. We developed a school implementation index score to explore associations between degree of implementation and intervention effects. Some studies have reported the number of lessons that were taught as a single measure for the degree of implementation [26, 27]. Since implementation is a complex process, a combination of different process indicators such as dosage, fidelity and quality of delivery at both the program as well as the support level play a role [20]. The theory driven selection of items in this implementation index is a major strength of our implementation index. As far as we know, a systematic tool that combines different process indicators into a single implementation index score is currently not available.

Although the development and subsequent use of an implementation index can be regarded as a strength of the study, this limits the study at the same time. First of all, the implementation index needs further validation. Second, data for the implementation index were derived from only one questionnaire completed after implementation of the 2-year DOiT program. This could have led to bias. Assessing degree of implementation during the implementation process may have provided more insight into the degree of implementation over time.

Third, we could not link teacher implementation data with adolescent data due to teacher and student turnover during the 2-year implementation; therefore, we had to aggregate data at school level. Further, the number of teachers ($n = 68$) reporting on program implementation at T2 in our study was limited. We had only data of 18 implementing schools and a relatively small number of teachers per school (range 2–7) were involved in program implementation. Due to the limited number of schools and the small variation in implementation index scores between schools, the results should only be considered exploratory and the index as presented here should be regarded as a first attempt and not as an established implementation index. More research with a larger sample size would be needed to confirm the structure of the indices.

The self-report of process indicators also limits the study. Teachers' self-report on process indicators was based on existing questionnaires [11, 30]. The psychometric characteristics of these questionnaires are unknown. Since the questionnaires were completed at the end of the school year, recall bias may have influenced the results. Direct observations during the lessons or log book data could have provided more detailed insight into the process indicators. However, observations may interfere with the

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dissemination process and log book data was incomplete.

Finally, as we evaluated the natural implementation process, it is also possible that adoption bias could have emerged. Since DOiT is an innovative program, schools that adopted and implemented DOiT may not have been representative of all prevocational schools in the Netherlands.

Conclusion

This study showed that we were able to recruit the required number of schools, teachers were satisfied with the DOiT lessons and teaching materials, but implementation of the program decreased towards the end of the program and only one third of schools wanted to continue using DOiT in the future. Further, using an exploratory implementation index, some evidence was found for an association between higher implementation index scores and program effectiveness, but more research is needed to test the validity of the implementation index. Future studies should continue to evaluate implementation of evidence-based programs to better understand if and how effectiveness is retained when disseminating evidence-based approaches into practice.

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Conflict of interest statement

None declared.

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