VETisnietVET

Studies on the prevention of excessive weight gain among adolescents

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COLOFON

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Studies naar het voorkomen van overmatige gewichtstoename bij jongeren

Proefschrift

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Part 1

Introduction

Chapter 1

General introduction

The high prevalence of overweight and obesity is an important determinant of avoidable burden of disease in the Netherlands and worldwide. Preventing excessive weight gain among children and adolescents can contribute to reducing this burden. The present thesis adds to the knowledge on obesity related risk behaviours, determinants of these risk behaviours and the prevention of excessive weight gain. In addition, this thesis evaluates the effects of FATaintPHAT, a computer-tailored intervention aimed at the prevention of excessive weight gain among adolescents. This introductory chapter provides background information to the studies presented in this thesis.

1 PLANNED HEALTH PROMOTION

To make optimal use of scarce resources and increase the likelihood of health promotion to have an effect, carefully developed, theory and evidence based interventions are needed. The systematic development of interventions has been described in planning models, such as the Precede-Proceed model [1] and the Intervention Mapping Protocol [2]. A basic framework that integrates such insights is shown in Figure 1 [3]. According to this model, the first step in health promotion planning is the identification of a health problem that is serious and/or prevalent enough to spend time and resources on and that can result in a significant improvement of public health. In the present thesis, this analysis concerns the prevalence of overweight and obesity among adolescents and its relation with adverse health outcomes in adolescence and later in life. In the second step, behavioural risk factors for developing overweight and obesity needs to be identified.

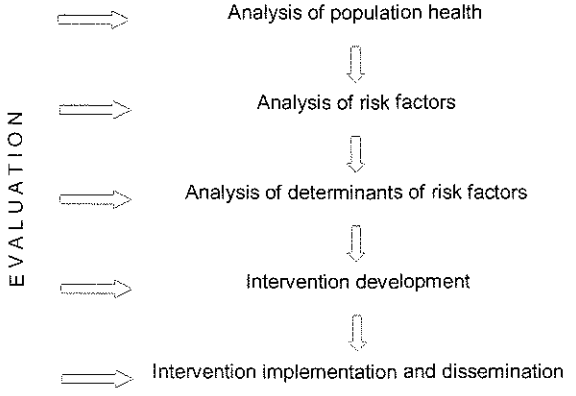

Figure 1 A model for planned health education and health promotion [3]

Subsequently the personal, social and environmental mediators or determinants of these behavioural risk factors need to be identified (step 3). Determinants are causal factors that induce an individual to engage in a particular behaviour. To change risk behaviours and ultimately reduce disease risk, interventions should be developed that address the important and changeable determinants (step 4). Interventions that have been shown to be effective, used and appreciated should be implemented and disseminated on a broader scale to have impact on population health (step 5). Each step should be based on careful evaluation.

2 ANALYSIS OF POPULATION HEALTH: OVERWEIGHT AND OBESITY

Even though the increase in overweight and obesity prevalence among adolescents seems to level off in some countries [4-7], the high prevalence of overweight and obesity is a major public health concern, because of its association with various adverse effects [8]. Adverse effects of childhood obesity are psychosocial (poor self esteem, depression and eating disorders), cardiovascular (dyslipidaemia, hypertension), pulmonary (sleep apnoea, asthma, exercise intolerance), gastrointestinal (gallstones), musculoskeletal (flat feet, low back pain) and endocrine (type 2 diabetes, precocious puberty) [9, 10]. Higher weight-related outcomes during childhood and adolescence have been associated with increased mortality during adulthood [11-13].

Overweight rates in the Netherlands were 13.3% among boys and 14.9% among girls in 2010, which was a substantial increase since 1980 (boys 5.1%, girls 7.2%)

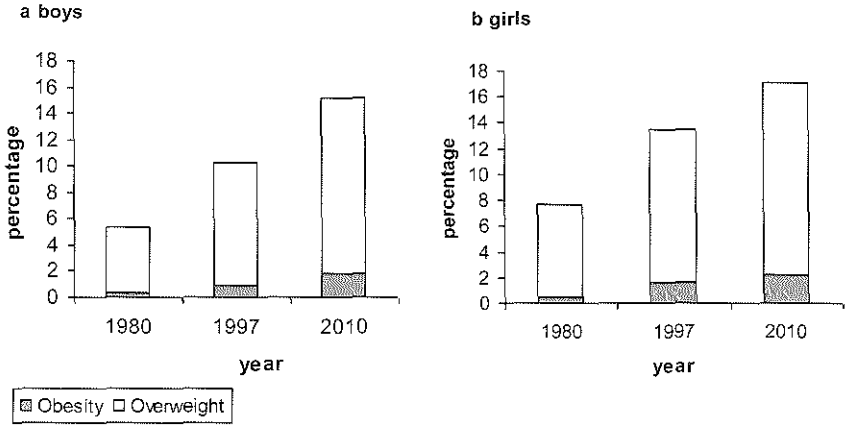

Figure 2 Overweight and obesity rates among boys (a) and girls (b) in the Netherlands

and 1997 (boys 9.4%, girls 7.2%) (Figure 2) [14]. This increase was also observed in obesity rates (1980: boys 0.3%, girls 0.5%; 1997: boys 0.9%, girls 1.6%; 2010: boys:1.8%, girls 2.2%) [14]. Moreover, overweight an obesity rates are higher than the national average in certain parts of the Netherlands. Jansen et al. [15] showed that in the Rotterdam area 21.4% of the 9-12 year old was overweight and 9.0% was obese in 2006. Childhood obesity rates in the United States have reached extremely high proportions, with 17% of children found to be obese according to the NHANES surveys of 2003 to 2006 [16]. Overweight and obese adolescents are likely to become overweight or obese adults [8, 17, 18]. Furthermore, treatment of overweight and obesity is generally disappointing [8, 19]. Therefore, prevention of excessive weight gain in children and adolescent is imperative to prevent the development of overweight and obesity.

3 ANALYSIS OF BEHAVIOURAL RISK FACTORS FOR OVERWEIGHT AND OBESITY

Overweight and obesity are the result of a long-term gradual weight gain caused by a long-term positive energy balance, i.e. energy intake (through the diet) exceeds energy expenditure (that can importantly be influenced through physical activity). Various specific behaviours regarding diet, physical activity and sedentary behaviours are considered to be related to the energy balance and overweight and obesity among adolescents (from now on referred to as energy balance-related behaviours). However, it is not yet clear which specific behaviours contribute to excessive weight gain in children and adolescents. Table 1 shows an overview of the current evidence for the different dietary, physical activity and sedentary behaviours and sub-behaviours. This overview is based on results from (reviews of) observational longitudinal and cross-sectional studies and intervention studies. For some behaviours the relation with excessive weight gain is studied among children and adolescents specifically. However, for some behaviours most evidence comes from studies among adults (Table 1). Level of scientific evidence was defined according to a frequently used categorization into four levels of strength (insufficient, possible, probable, convincing) depending on the number and type of studies carried out and the consistency of the results [20]. This categorization is generally applied to categorization of single studies, but in this overview also applied to categorize the results of reviews.

Table 1 Level of evidence for the association between behaviours and excessive weight gain or overweight/obesity from longitudinal cohort and review studies among children/adolescents and the adult/total population

Behaviour	Evidence	Reference (child/adolescent)	Reference (adults/all ages)
Dietary behaviours			
Fruit/vegetable	Possible	34-36	37-39
Fibre	Convincing		21, 40-42
Dairy products	Insufficient	35, 43, 44	45, 46
Fast food	Insufficient	34, 35, 47	48
Sugar-sweetened beverages	Probable	34, 35, 43, 49	50-52
Unhealthy snacks	Insufficient	35, 49	
breakfast	Probable	34, 35, 47, 53-56	
Portion size	Possible	57, 58	41
Physical activity			
Overall physical activity	Probable	58-62	41, 63
PA education	Insufficient	64, 65	
Active transport	Insufficient	66-69	
Sedentary behaviours			
Overall sedentary behaviours	Possible	34, 62	
TV viewing	Convincing	58, 70-72	
Computer use gaming	No relationship	58, 70, 71	

The strength of evidence is based on categorization into insufficient, possible, probable and convincing, based on the number and type of studies carried out and the consistency of the results [20]

3.1 Dietary behaviours/energy intake

For dietary behaviours convincing evidence is found for the relationship between consumption of fibre and weight related outcomes among adults, while no evidence is available for children or adolescents. Dietary fibre is the edible part of plant foods that is resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine [21]. Dietary fibre may facilitate body-weight control through different physiologic mechanisms. Fibre-rich foods tend to be more satiating, slow down the digestion, could provide a mechanical barrier to the enzymatic digestion of other macronutrients such as fat and starch, and could improve insulin sensitivity [21]. Other behaviours that are probably related to excessive weight gain in youth are consumption of sugar-sweetened beverages and skipping breakfast. Sugar-sweetened beverages are thought to bring on additional calories without satiety promotion, while breakfast consumption is often a rich source of fibre and is shown to be related to fewer [22] and less high-fat snack consumption [23]. Few studies or inconclusive relationships are found for fruit, vegetable, dairy and fast food consumption and portion size with weight gain (Table 1).

3.2 Physical activity/energy expenditure

The role of physical activity behaviours in excessive weight gain is poorly understood. In general, higher levels of physical activity are related to the prevention of excessive weight gain. However, which specific physical activity behaviours play a role in this relationship is largely unclear. Physical education at school, sports participation and active transport are probably protective for excessive weight gain (Table 1).

3.3 Sedentary behaviours

Television viewing, computer use and gaming are the sedentary behaviours most often studied in relation to overweigh/obesity among children and adolescents. Only for television viewing convincing evidence for the relation with excessive weight gain has been found. Possible working mechanisms for this relationship include 1) a higher consumption of unhealthy food during viewing (such as sweets, cakes and fast foods) [24-27], 2) exposure to food adverts [28, 29], 3) replacement of physical activities by television viewing resulting in a reduction in total energy expenditure (although physical activity was found in one study not to be a mediator in this relationship [30]), or 4) reduction of energy expenditure during television watching [31], even thought this explanation is under debate [32].

In summary, for many behavioural risk factors for excessive weight gain the evidence is insufficient. Therefore, more and stronger studies are needed to contribute to the evidence of associations between specific dietary, physical activity and sedentary behaviours and excessive weight gain in children and adolescents. Moreover, it is increasingly acknowledged that multiple behaviours are involved in excessive weight gain [33] and research on multiple risk behaviours simultaneously is needed in addition to the study of the relation between single behaviours and weight gain. The study described in chapter 4 of this thesis adds to this evidence with a study on trends in behavioural risk factors and the possible relationship with concurrent trends in obesity.

4 ASSESSING DETERMINANTS OF ENERGY BALANCE-RELATED BEHAVIOURS

To be able to improve risk behaviours, it is important to identify the most important and best changeable determinants of that target behaviour [3]. Numerous models are used to study and describe the relation between determinants and behaviour.

4.1 Individual determinants

Stage theories, such as the Precaution Adoption Process Model, are used to study behaviour change (see Figure 3). Stage theory suggests that behaviour change occurs through distinct stages and that in each stage people behave differently and have different beliefs about severity, personal susceptibility, precaution effectiveness and the decision to take action. Moreover, these theories postulate that the types of information and interventions needed to move people closer to action will vary from stage to stage [73]. According to the Precaution Adoption Process Model, awareness of one's risk behaviour is an important determinant for the intention to change [73]. Lack of awareness is a determinant that is often an issue in complex health-related behaviour, such as dietary intake and physical activity [74, 75]. Stage theories comprise both the motivational (ending in a positive intention) and the volitional (ending in successful performance) phase of behaviour change.

The relation between personal determinants of behaviour and actual behaviour is described in various models [76]. The Theory of Planned Behaviour is one of the most widely used models in studying potential determinants of health behaviours, including dietary, physical activity and sedentary behaviours [77-79] (See Figure 4).

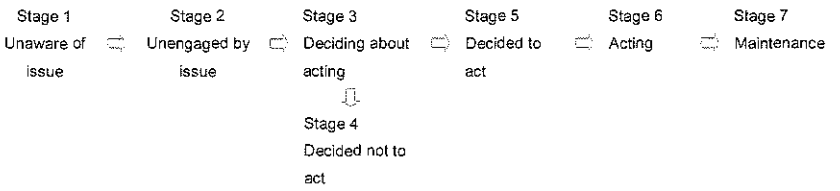

Figure 3 A schematic representation of the stages of the Precaution Adoption Process Model

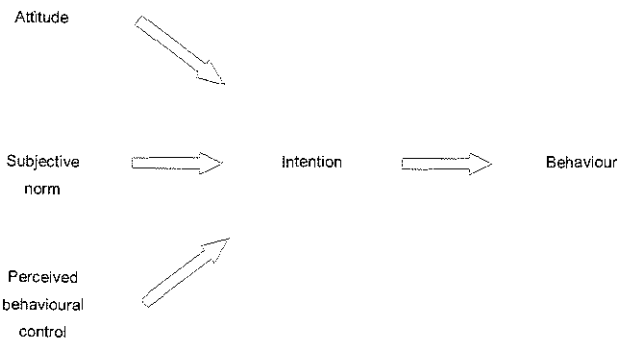

Figure 4 The Theory of Planned Behaviour

This model focuses on the motivational phase of behaviour change - that is on determinants to improve the intention to perform or change behaviour. The relevance of this theory for energy balance-related behaviours is supported by many studies [80-82]. The theory postulates that a behaviour is predicted by an intention to engage in this behaviour, and that this intention is determined by attitudes (a weighing of perceived pros and cons of the behaviour), subjective norm (perception of important others' expectations regarding the behaviour), and perceived behavioural control (perceived difficulty to engage in the behaviour) [83]. The volitional phase of behaviour change focuses on determinants that predict goal attainment [84]. A positive intention does not automatically result in action and the volitional phase focuses on determinants that explain the step from intention to action. Goals setting and action and coping planning are important factors in this phase [84]. However, much more research has focussed on the motivational phase as compared to the volitional phase.

4.2 Environmental determinants

More recently the possible influence of the environment in supporting or inhibiting healthy choices in energy balance-related behaviours is acknowledged. Socio-ecological models describe the relation between the environment and behaviour [85, 86]. The ANGELO framework (analysis grid for environments linked to obesity) distinguishes several types and sizes of environments that can have an influence on obesity related behaviours [86]. The basic framework is a 2 x 4 grid which dissects the environment into environmental size (micro and macro) by type: physical (what is available), economic (what are the costs), political (what are the "rules"), and socio-cultural (what is appropriate according to attitudes, beliefs and norms and what is the modelling behaviour of for instance the parents). The EnRG framework (Environmental Research framework for weight Gain prevention) is a more elaborate example of a socio-ecological model combining insights of the ANGELO framework and the Theory of Planned Behaviour, and which distinguishes between personal or cognitive determinants, such as attitudes or risk perception, and environmental determinants, such as the physical and social environment (Figure 5) [85]. In this model environmental factors are hypothesised to have a direct and an indirect (via cognitions) effect on a behaviour [85].

4.3 Evidence for behaviour specific determinants among adolescents

To identify important personal determinants for the specific energy balance-related behaviours and target audience numerous determinant studies have been

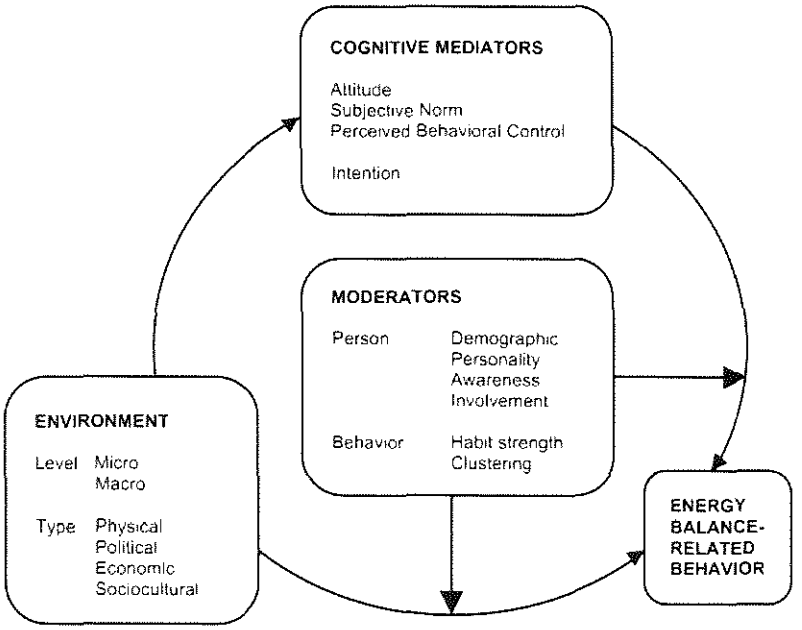

Figure 5 Environmental Research framework for weight Gain prevention [85]

conducted, largely based on the motivational theories. Literature on personal determinants of sugar-sweetened beverage consumption shows that attitudes, subjective norm and intention towards consuming sugar-sweetened beverages are related to intake [82, 87-91]. The relationship between perceived behavioural control and sugar-sweetened beverages consumption is unclear [82, 87, 88, 90-92]. A cross-sectional study on determinants of high-fat snack consumption showed that a more positive attitude towards eating high-fat snacks was associated with consumption of high-fat snacks [93]. For fruit and vegetable consumption evidence suggests that children with more knowledge, a more positive attitude and a higher self-efficacy were more likely to eat fruit and vegetable daily [93-95]. For physical activity attitude, subjective norm, self-efficacy/perceived behavioural control and intention were identified as important correlates or predictors in the literature [81, 96-103]. Even though there is some evidence for relevant determinants of energy balance-related behaviours among adolescents, the evidence is scattered and limited, which supports that more research on identifying important personal determinants of the various dietary, physical activity and sedentary behaviours is needed. In chapter 3 of this thesis one of such studies is presented.

A recent review on environmental correlates of obesity-related dietary behaviours showed associations between parental intake with children's fat, fruit and

vegetable intakes and between parent and sibling intake with adolescent's energy and fat intake [104]. Moreover, a less consistent but positive association was found for availability and accessibility with children's fruit, vegetable, fat and sugar-sweetened beverage intake (for boys) [92, 104]. Factors in the school environment, such as the availability, and peer influence have been found to relate to snacking and sugar-sweetened beverage consumption [105]. Moreover, social support, modelling, availability and accessibility of healthy and less healthy foods are important for healthful nutrition behaviours [106]. A recent review on environmental correlates of physical activity behaviours showed that fathers' physical activity, time spent outdoors and school physical activity-related policies were related to physical activity in children, while support from significant others, mothers' education level, family income, and non-vocational school attendance were related to physical activity in adolescents. Low crime incidence was a characteristic of the neighbourhood environment associated with higher physical activity in adolescents [107]. These outcomes suggest that social support and modelling are important and that parents and peers have a crucial role in the behaviours of children. Parents should not only provide a good example, but they can also support healthy eating and physical activity behaviours in their offspring by setting rules and by using supportive parenting styles.

Environmental influences are hypothesized to influence behaviour either directly or indirectly via cognitions [85]. To increase our understanding of the mechanisms between environmental and cognitive determinants with behaviour, the mediating role of cognitive factors in the relationship between environmental factors and behaviour is currently an important target in behavioural research. In chapter 4 of this thesis this is studied for sugar-sweetened beverages.

5 INTERVENTION DEVELOPMENT

5.1 School-based interventions for overweight and obesity prevention among adolescents

Schools can be considered as ideal settings for improving children's and adolescents' dietary, physical activity and sedentary behaviours [108]. Education can be provided to students to address individual level determinants and induce individual change processes. At the same time, school environments can be improved to support healthy eating and physical activity. School policies, qualified staff, role modelling of teachers and incentives in the school's physical environment are other

important factors amenable to change in order to improve health behaviour [109, 110]. An important advantage of using the school setting for health promotion is the reach of all students irrespective of their socio-economic or cultural backgrounds.

Recent reviews show that few school-based studies found effects on weight related outcomes [108, 111-113]. Nevertheless, combined dietary and physical activity interventions may be the most promising in preventing children becoming overweight in the long term [108, 113-115]. A review of school-based intervention studies (n = 11) conducted in Europe [108] showed that there was limited evidence that multi-component interventions focusing on healthy diets and physical activity habits and combining an educational and an environmental component had a positive impact on obesity measures in adolescent girls, but not in boys. The effective interventions used an online computer-tailored program, and combined this with an environmental component for physical activity (including organized non-competitive activities, extra sports and physical education classes) and for nutrition (including changes in school canteens, reduced pricing and/or increased availability of healthy foods such as water and fruit, and increased pricing and/or reduced availability of unhealthy foods such as soft drinks and snacks). These strategies can be considered to be promising in preventing overweight in adolescent girls in Europe.

In addition, evidence from reviews showed that educational interventions were most likely to show an effect on dietary behaviours [111], while interventions that combine environmental and educational strategies might have an effect on weight related outcomes in girls, but not boys [108]. Whether computer-tailored personalized education in the classroom is superior to a generic classroom curriculum has not yet been convincingly demonstrated, but results seem promising in adolescents [108]. Physical activity interventions may be more effective among younger children and girls [112]. Future studies of sufficient duration are needed so that (sustained) effects on obesity indicators can be documented. The effects of computer tailoring among adolescents need further examination. Our study on the effects of the computer-tailored intervention FATaintPHAT described in chapters 5 till 8 will add to this knowledge.

5.2 FATaintPHAT: weight gain prevention among adolescents

To contribute to decreasing the prevalence of overweight and obesity among adolescents the computer-tailored intervention FATaintPHAT (VETisnietVET in Dutch) aiming to prevent excessive weight gain was developed. Information gathered

in the prior steps of the planned approach was used to inform the development of FATaintPHAT. Although truly convincing evidence is not yet available, many behaviours are thought to be involved in the prevention of excessive weight gain. FATaintPHAT targeted the following behaviours: consumption of snacks, sugar-sweetened beverages, fruit, vegetables, and fibre, as well as physical activity, television viewing and computer use. For these behaviours the most compelling evidence is available and these behaviours are biologically most likely related to energy balance. In line with theories that emphasize that the motivational as well as the volitional phase of the behaviours change process need to be influenced in order to induce sustained behaviour change, the intervention included elements to address both these phases [84]. The theoretical models used for the motivational phase were a combination of the Precaution Adoption Process Model and the Theory of Planned Behaviour. These theories define important and changeable determinants to be addressed in the intervention: awareness, attitude, subjective norm, perceived behavioural control, and intention to change. In addition, other psychosocial constructs identified as being relevant in earlier studies were addressed, namely social support and skills. For the volitional phase of behaviour change we used self-efficacy and action planning as determinants of goal attainment.

To change the above mentioned determinants a variety of methods were used: behavioural feedback, comparing the student's behaviour with guidelines for that behaviour (normative feedback), and with behaviour of peers (comparative feedback), prompts for intention re-evaluation, decisional balance to change attitudes, instructions on how to perform/change a behaviour to improve self-efficacy, prompts for barrier identification to induce coping planning, suggestions on how to organize social support and implementation intentions to induce action planning [116, 117].

We developed FATaintPHAT as a web- and school-based intervention that was used during school lessons in the first-year of secondary education. An interactive web-based intervention might be attractive for adolescents. As described earlier, the school setting provides a natural learning environment for adolescents and has the advantage that all adolescents from all socio-economic and ethnic backgrounds are reached. We used computer tailoring as the main technique to individualize the information and adapt to the students personal characteristics and beliefs.

5.3 Computer tailoring

5.3.1 Rationale for choosing computer tailoring

People are often unaware of their risk-behaviour, making it unlikely that these people do consider behaviour change [118]. Making people aware of their risk behaviour and guiding them through further phases of behaviour change can be facilitated by personalized feedback and change information. Computer tailoring is a health education technique that is specifically suited to provide this type of feedback to larger numbers of people and has been recognised as a promising health communication technique in energy balance related behaviour change, such as change in dietary and physical activity behaviours [119]. Computer tailoring is intended to address each specific person personally, by addressing characteristics that are unique to that person, related to a specific behaviour, and derived from an individual assessment [120].

5.3.2 Procedure of computer tailoring

To generate computer-tailored feedback, three components are necessary (Figure 6): 1) a screening instrument to assess the behaviour as well as the most important determinants of, and barriers for, behaviour change, 2) a message library with feedback messages tailored to all possible screening results, and 3) a computer program that selects relevant feedback messages from the message source file based on the individual screening results and presents this information to the user [118].

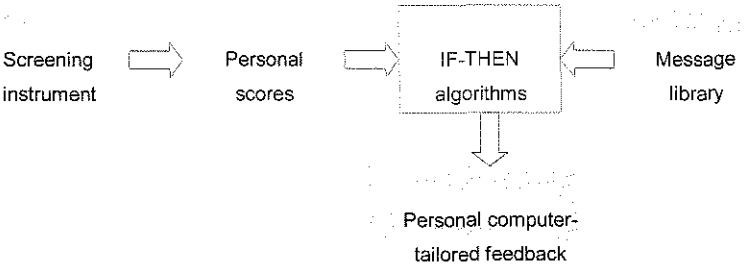

Figure 6 The procedure of computer tailoring

5.3.3 Effectiveness of computer tailoring

Systematic reviews and meta-analyses indicate that computer tailoring is likely to be more effective than generic health education for modifying dietary [121-124] and

possibly physical activity [121, 124, 125] behaviour among adults. Even though there are few studies that have evaluated the effects of standalone computer-tailored interventions among adolescents up till now [126], it is to be expected that computer-tailored interventions can also be successful for adolescents.

Various characteristics such as the number of sessions or the number of behaviours targeted can moderate the intervention effect [123, 124]. A recent review [124] shows that dynamically tailored interventions (i.e. iterative assessments and feedback) showed larger effect sizes then statically tailored interventions, and these effects were also maintained over a longer follow-up period. This larger effect size for dynamically tailored interventions could be explained by the more frequent overall contacts that dynamic tailoring necessitates. Moreover, it appears that more than just providing additional contact with dynamic tailoring, updating feedback to reflect a person's changes may increase information relevance and depth of processing. The same review [124] further showed that intervening on up to three multiple behaviours at the same time does not negatively impact behavioural outcomes, with suggestion of a trend for larger effects as the number of behaviours increased from one to three. The effectiveness of multiple behaviour change could reflect an underlying general health orientation that influences engagement in behaviours [33, 127]. Moreover, the effect of tailored interventions seems to increase with an increasing number of theoretical constructs and factors (cognitive, demographic, behavioural) tailored on [123].

5.3.4 Working mechanism of computer tailoring

A variety of theories are used to explain the potential working mechanisms of computer tailoring. Although in recent years various studies and reviews have focused on disentangling the specific working mechanisms of computer tailoring to improve their future effectiveness [123, 124, 128], there are still many gaps in understanding the working mechanisms of computer tailoring, and research among children and adolescents is largely lacking.

Hawkins et al. [129] propose three potential working mechanisms of computer tailoring that enhance information processing and which possibly makes computer tailoring more effective compared to generic information. The first mechanism is increased attention. Obviously, attention to a message is a prerequisite for the message to have any impact. Therefore, a common aim of tailoring is to increase attention. This is generally achieved by communicating to the receiver that messages address their personal attributes, preferences and needs. If a message is

attended to it needs to be comprehended as well to lead to any effect. Research shows that tailored messages are more likely to be read and remembered [130, 131], and studies measuring differences in intention allocation between tailored and non-tailored messages objectively indicate that tailored nutrition education messages indeed induce higher attention than generic messages [132, 133]. The second proposed working mechanism is effortful processing. The Elaboration Likelihood Model of persuasion [134] posits that during 'central route' processing or elaboration people are active information processors who "think about messages carefully, relate them to other information they have encountered in the past, and consider the messages in the context of their own life experience" [135, 136]. Central processing typically leads to deeper and more persistent persuasion than does peripheral processing [137]. Information that is perceived as personally relevant is more likely to be actively and thoughtfully processed [137]. A third proposed working mechanism, a further extension of effortful processing, is that tailoring may encourage self-referential thinking by the receiver. To the extent that tailoring encourages receivers to focus on themselves, they may identify discrepancies between, for example, their actual and ideal behaviours. Such self-referential thinking may also increase the likelihood of central processing [138]. Information that is actively and thoughtfully processed is more likely to influence awareness, knowledge, attitudes, beliefs, and behaviours [120, 129]. Research supports these proposed working mechanisms. Early studies showed that tailored messages were more likely than non-tailored messages to be read, remembered and viewed as personally relevant [130, 131, 139, 140]. Moreover, it commands greater attention, is processed more intensively, contains less redundant information, and is perceived more positively by health consumers [141]. Additionally, the effects of tailoring may be mediated by perceived personal relevance and perceived individualization [142].

Besides attempting to influence message processing, tailoring strategies also attempt to alter psychosocial constructs to directly influence behaviour. Three distinct strategies can be used to achieve the tailoring goals (information processing and influencing behaviours): 'personalization', 'feedback' and 'content matching' [129]. Personalization strategies are generally used to enhance message processing, though there is some evidence that they may also affect behaviour directly [143]. Personalization attempts to increase attention or motivation to process messages by conveying, explicitly or implicitly, that the communication is designed specifically for 'you'. Three of the most common personalization tactics are 1. identification, 2. raising expectations, and 3. contextualization. Identification is operationalized by identifying the recipient by name; raising expectation of customization involves overt claims of customization, such as 'The following

health information has been created especially for you'; and contextualization is to frame one's message in a context that is meaningful to the recipient. The second strategy, providing feedback, involves presenting individuals with information about themselves, obtained during assessment or elsewhere. Whereas personalization mainly seeks to promote attention and processing, feedback strategies also target psychosocial determinants of health behaviours. Three feedback tactics, descriptive, comparative and evaluative feedback, are frequently combined in tailoring programs. Descriptive feedback ranges from simply restating or acknowledging information (e.g. 'You said you drink two glasses of soft drink per day.') to providing information based on more complex processing of their responses (e.g. 'Based on your answers, we determined that you eat 24 grams of fat per day.'). Descriptive feedback may influence determinants of health behaviour by stimulating self referential thinking about specific beliefs, behaviours or environmental constraints related to the outcome of interest. It may also produce non-specific effects such as 'feeling acknowledged', 'feeling understood' or creating a sense of presence [129, 144], which could build a relationship and favourably influence interpretation of the message or lower resistance to persuasion. Comparative feedback compares a person's attitudes, beliefs or behaviours to those of others. Social comparison information may evoke effortful processing on self-evaluation, while normative comparison may stimulate changes in perceived norms, attitudes or beliefs. Tailored comparative feedback may also validate or reinforce beliefs. Evaluative feedback adds a level of interpretation, judgment and/or inference about an individual's attitudes, beliefs or behaviours (e.g. 'You need to eat more fruits and vegetables'). Evaluative feedback is often used to introduce content matching. Content matching (the third strategy) attempts to direct messages to individuals' beliefs on key theoretical determinants (e.g. knowledge, attitudes, self-efficacy) of the behaviour of interest. By changing the most relevant determinants improvement in the particular behaviour might be achieved.

6 INTERVENTION IMPLEMENTATION AND DISSEMINATION

Interventions that have been shown to be effective, used and appreciated should be implemented and disseminated on a broader scale to have impact on population health. Already during the development of the intervention one should think of the implementation phase to develop an intervention that can be implemented on a broader scale and that is needed in and shaped for practice [2]. An intervention in schools that can be easily implemented by teachers might have favourable prospects for implementation.

7 EVALUATION

Evaluation is important in each step of planned health promotion. Different studies in this thesis add to the evaluation of the steps on important behaviours and determinants. Studies on risk factors and determinants should have strong designs to infer causal relationships between behaviours and weight-related outcomes and possible determinants and behaviours. Longitudinal studies are generally better for inferring causality, although determinants or risk factor status might change during the follow-up period, obscuring possible relationships. Experimental studies can proof causality, but the intervention needs to be effective in changing the mediator (risk factor or determinant) and the external validity should be considered.

This thesis adds to the evaluation of one specific intervention, FATaintPHAT. We assessed whether this intervention is able to change behaviours and/or health outcomes (effect evaluation) and whether the intervention was used and appreciated by students and teachers (process evaluation). Understanding use and appreciation of computer-tailored interventions among adolescents, besides knowing its effects, is important for interpretation of the findings and improvement of the intervention to increase intervention effectiveness [1, 3]. Further details on the evaluation design are described in chapter 6. Important design aspects of evaluation studies are randomization, having a control group, follow-up period after the intervention, sample size and the use of outcome measures that properly evaluate the intervention goals [145].

Outcome measures of determinant and evaluation studies should be reliable and valid. Objective measures are generally more reliable and valid as compared to self-report by means of a questionnaire. However, these objective measures are not always possible to obtain in studies, due to design and financial aspects.

8 AIMS AND OUTLINE OF THE THESIS

This introductory chapter shows that there is a large body of evidence (although mostly still inconclusive) on risk behaviours of excessive weight gain among adolescents, that there is less evidence on related behavioural determinants, that we have little knowledge on effective interventions to prevent excessive weight gain among adolescents and that computer tailoring might be a very powerful approach to enhance intervention effectiveness.

This thesis contributes to the prevention of excessive weight gain among adolescents by filling in some gaps in the evidence. Two larger aims can be identified.

Part 1: Contribute to the understanding of specific dietary, physical activity and sedentary behaviours that are related to the energy balance and the personal and environmental predictors among adolescents.

Part 2: Evaluate the main and differential effects, use, and appreciation of FATaintPHAT, a computer-tailored health education program aimed to contribute to the prevention of excessive weight gain among adolescents.

The specific research questions that are addressed in the different chapters are:

Chapter 2 - What are the psychosocial and demographic predictors of the intention to prevent excessive weight gain among adolescents aged 12-13 years?

Chapter 3 – Are there favourable changes in energy balance-related behaviours over the period 2000/2002 to 2004/2005 in a region in Texas where obesity prevalence levelled off, compared to a region in Texas where obesity prevalence increased? And is the difference in obesity prevalence between the two regions associated with physical activity, sedentary or dietary behaviours?

Chapter 4 – What are the cognitive and home environmental predictors of changes in sugar-sweetened beverage consumption among adolescents over a four month period? And is the prediction of the environmental factors on sugar-sweetened beverage consumption mediated by the cognitive factors?

Chapter 5 – Describe the steps in the planned development of the FATaintPHAT intervention and the study design for evaluating the effectiveness, use and appreciation of the intervention.

Chapter 6 – What are the short and longer-term effects of FATaintPHAT among adolescents on anthropometrics (BMI, percentage overweight, waist circumference; 2-year follow-up) and on the targeted behaviours (consumption of sugar-sweetened beverages, snacks, fruit, vegetables and fibre, television viewing, computer use, and physical activity behaviours; 4-months and 2-years follow-up)?

Chapter 7 – Are the effects of FATaintPHAT on fruit, vegetable, sugar-sweetened beverage and snack consumption moderated by demographics (gender, educational level, ethnicity), an environmental factor (availability at home), awareness of unhealthy behaviours or intention to change?

Chapter 8 – What are the students' use and appreciation of FATaintPHAT? Was this use and appreciation different according to gender, education, ethnicity, or weight category? Are use and appreciation related to the behavioural outcomes at 4-months follow-up?

Finally, in chapter 9 the main results of these studies are brought together and a critical reflection on the findings and methodology is provided. Methodological considerations and recommendations for practice and further research are presented.

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Part 2

Risk factors and determinants

Chapter 2

Predictors of the intention to prevent excessive weight gain in youth

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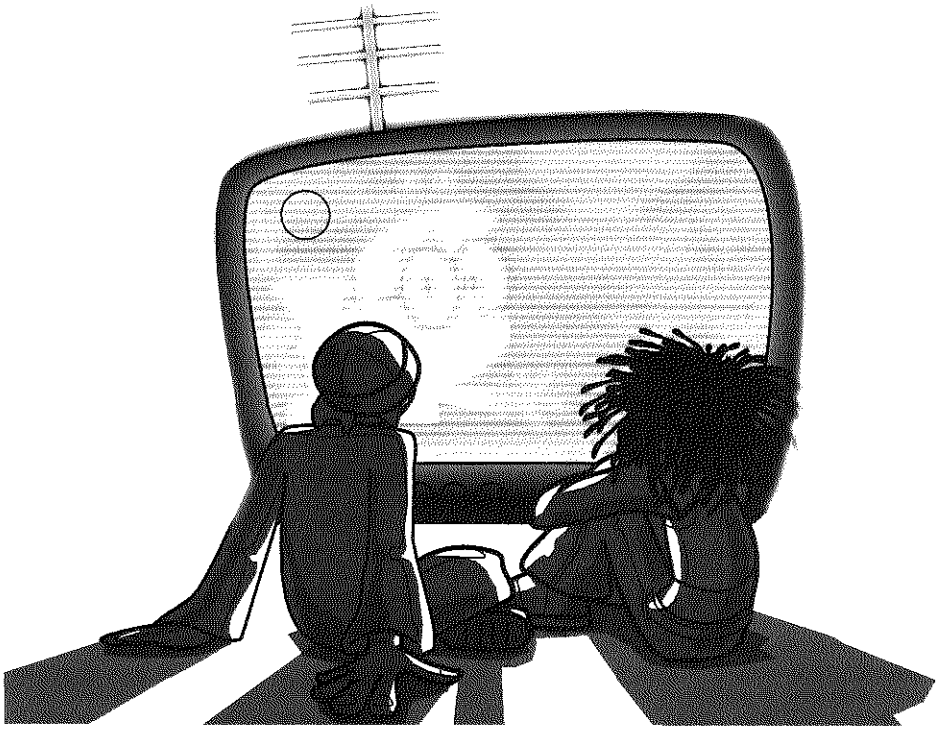
Submitted for publication



ABSTRACT

Objectives: Examine psychosocial factors, BMI, perceived weight and demographics as correlates of adolescents' intentions to prevent excessive weight gain.
Methods: Students (12-13 years) completed questionnaires at baseline and four-month follow-up. Regression analyses were performed (n=345).
Results: 60% showed a positive intention towards the prevention of excessive weight gain. A positive change in attitude and perceived internal control, and higher perceived weight, were related to a positive change in intention.
Conclusion: A small majority of adolescents had a positive intention to prevent gaining excessive weight. A positive attitude and higher perceived internal control was related to a positive intention.

INTRODUCTION

Prevention of excessive weight gain (weight gain beyond regular growth) among adolescents is the primary strategy to prevent overweight and obesity, since weight loss interventions are mostly ineffective [1]. Weight management can prevent people from becoming overweight, or (if already overweight) becoming more overweight or obese. Experts agree that it is important to improve skills and behaviours for prevention of excessive weight gain [2,3] and many intervention programs are being developed for this purpose [4]. Currently, most research for obesity prevention is focused on behavioural factors related to the prevention of excessive weight gain among adolescents [5-8], omitting a focus on the higher level goal of prevention of excessive weight gain. The intention to prevent excessive weight gain may be an important driver for intention and enactment of changes in relevant weight related behaviours and is therefore a potentially important determinant to target in interventions aimed at the prevention of excessive weight gain [9]. To be able to modify the intention to prevent excessive weight gain, it is important to have a good understanding of the underlying factors.

The Theory of Planned Behaviour (TPB) is a widely used theory to explain and predict health behaviour [10-12]. The relevance of this theory for energy balance-related behaviours has been established [13-15]. Even though prevention of excessive weight gain is not a behaviour in itself, we believe that the TPB can be a suitable framework to help understand adolescents' intentions to prevent weight gain. The theory has been used to study prevention of excessive weight gain among adults [16]. Following the theory, we hypothesized that a positive attitude, subjective norm and perceived behavioural control contribute to a positive intention to prevent excessive weight gain among adolescents.

In addition to the variables of the TPB, other constructs may play a role in the intention to prevent excessive weight gain and, therefore, we added some potentially important variables to our main theoretical framework. For example, actual and perceived body weight might be important since they are also related to the intention to lose weight and to dieting behaviours [17,18]. We hypothesized that adolescents who perceived their weight as being high and those who had a higher BMI would have a more positive intention to prevent excessive weight gain. Furthermore, perception of personal risk such as conceptualized in The Health Belief Model [19] and the Protection Motivation Theory [20], may play a role in the prevention of excessive weight gain. We hypothesized that adolescents who perceive they are at risk for gaining excessive weight might have a more positive intention

to prevent this. Finally, behaviour or issue-specific locus of control is known to be related to weight management [21], and this may also apply to prevention of weight gain among adolescents. We assumed that adolescents who think they can control excessive weight gain themselves (perceived internal control) are likely to have a more positive intention.

The main aim of the present study was to gain insight in the psychosocial predictors of the intention to prevent excessive weight gain among adolescents. More specifically, among adolescents aged 12-13 years we explored associations between attitudes, subjective norms, perceived behavioural control, risk perception and perceived internal control and intention to prevent excessive weight gain. We also investigated the relation between the more distal factors, i.e. body mass index (BMI), perceived weight and demographic factors, and the intention to prevent excessive weight gain. The secondary aim was to examine and compare the outcomes based on cross-sectional and longitudinal analyses. Most studies exploring potential predictors of intentions or behaviour use a cross-sectional design. However, it has been shown that the associations between cognitions and intentions in cross-sectional analyses may differ strongly from predictive relations in longitudinal analyses [22, 23].

METHODS

Study design and participants

This study used data of the FATaintPHAT intervention study. Adolescents in the control arm of the FATaintPHAT study were included in the present investigation. The study design and intervention of the whole FATaintPHAT study are described in detail elsewhere [24]. FATaintPHAT is a study that evaluates the effectiveness of an intervention aimed at preventing excessive weight gain through changes in energy balance-related behaviours. Seventy schools for secondary education in the area of Rotterdam, the Netherlands, were invited to participate in the study through invitational letters and follow-up telephone calls. Twenty-three schools consented to participate in the study and were randomly assigned into 11 intervention and 9 control schools (3 control schools withdrew due to difficulties with informed consent procedures). During the school year 2006-2007 measurements were made among adolescents in their first year in secondary school (aged 12 to 13 years) at baseline (November to February) and at four-month follow-up (March to June). The participating schools ranged from vocational level up to university

preparatory level. In the control arm, informed consent was obtained from 398 students (56% of the invited students). The study was approved by the Medical Ethics Committee of the Erasmus University Medical Centre.

Procedure

After explaining the study via a letter distributed by the schools, written informed consent was obtained from parents and students. At baseline and at follow-up, electronic, self-administered questionnaires were used to assess cognitions about the prevention of excessive weight gain and perceived weight. Questionnaires were administered during a classroom lesson (about 45 minutes) under the supervision of a research assistant. At baseline the height and weight of the students were measured by trained research assistants. To increase participation, five MP3-players were raffled at the end of the study among students who had completed all measurements.

Measures

Psychosocial predictors of the prevention of excessive weight gain

Derived from our theoretical framework consisting of the TPB and additional constructs, questions about the concept of gaining excessive weight (intention, attitude, subjective norm, perceived behavioural control, risk perception, perceived internal control and perceived weight) were measured on a five-point bipolar scale at baseline and at four-month follow-up. The questionnaire was pilot-tested on comprehensibility. Questionnaire items are presented in the Appendix.

For the descriptives and the regression analyses intention was dichotomized because the distribution was skewed and transformations did not normalize the distribution. Possible determinants were dichotomized to increase comprehensibility of the results. Based on the distributions and the clarity of the interpretations, positive (+2, +1) scores for each cognition were combined, as were the negative/neutral (-2, -1, 0) scores.

Demographics

Age, gender and educational level were self-reported. Educational level was categorized as lower (lower vocational and pre-higher vocational training) or higher (university preparatory secondary education). Ethnicity was derived from

self-reported country of birth, and country of birth of both parents, according to Statistics Netherlands [25]. Respondents were categorized as having either a Western (both parents born in Europe, North-America, Oceania, Indonesia or Japan) or a non-Western (at least one parent born elsewhere) ethnic background.

BMI

Body height was measured twice without shoes using a Seca 225 mobile height rod with an accuracy of 0.1 cm. A calibrated electronic digital floor scale (SECA 888 class III) was used to measure (with an accuracy of 0.2 kilogram) the body weight of the students, who were wearing sports clothes (no shoes) or their underwear and a T-shirt. The BMI was calculated as weight (in kilograms) divided by height (in meters) squared.

Analyses

Respondents with missing data (n=53) on the dependent variable or on the potential determinants were deleted, resulting in 345 complete cases in the analyses.

For the descriptive analyses we categorized students as either underweight, healthy weight or overweight, according to the BMI cut-off levels proposed by the International Obesity Taskforce [26] and van Buuren [27]. Differences in perceptions between baseline and follow-up were tested using McNemar's test for dichotomous and paired t-test for continuous variables.

We performed cross-sectional regression analyses of the baseline data to examine significant associations between psychosocial factors and intention. In addition, we performed longitudinal regression analyses to identify psychosocial predictors of the intention to prevent excessive weight gain. Hierarchical regression analyses with forced entry were performed to assess the association between the possible determinants and intention to prevent excessive weight gain [28]. First, we fitted a model with the distal variables gender, education and ethnicity. Second, we added the weight-related variables perceived weight and actual weight (BMI) to the model. Third, we added the psychosocial factors attitude, subjective norm and perceived behavioural control, risk perception, and perceived internal control to the model. For the longitudinal analyses, looking at change in intention, we used the intention measure at follow-up as the dependent variable and adjusted for baseline intention in order to observe the change in intention over time [29]. In three subsequent steps i) gender, education and ethnicity; ii) baseline values

of perceived weight and BMI; and iii) change in cognitions, were added to the model. For the cognitions we calculated change scores by subtracting the continuous value at baseline from the continuous value at follow-up. This allowed us to assess whether a change in possible determinants predicted a change in intention. Nagelkerke R-square was computed for each model. Alpha was set at 0.05. For the regression and the descriptive analyses SPSS 15.0 was used. The sample size was not large enough for conducting sufficiently powered stratified analyses by gender or educational level.

Need of multi-level regression analyses was tested by fitting models with the intercept only, to examine the significance of the between-schools variance in the (change in) intention to prevent excessive weight gain. Significance was calculated with a one-tailed Wald statistic following a Chi-square distribution with one degree of freedom. A significant variance would indicate that the individual behaviours cluster within schools. Multilevel logistic regression analyses were performed using MlwiN 2.02. A two-level structure was used (adolescents in schools) to take into account the nesting structure of students within schools [30]. The between-school variances were not significant in both the cross-sectional and the longitudinal analyses and thus no multi-level analyses are presented.

RESULTS

In the present study, 51% of the participants were girls, 21% were of non-Western ethnicity, 51% attended vocational education, the mean age was 12.6 (SD 0.58) and the average BMI was 19.2 (SD 2.96). Approximately 13% of the participants were overweight (including obesity) and 20% perceived themselves as being overweight.

Table 1 shows that at baseline a majority of adolescents (68%) had a positive intention toward prevention of excessive weight gain. At baseline, most adolescents showed a positive attitude (77%), subjective norm (62%) and perceived behavioural control (75%) toward prevention of excessive weight gain. About 14% of the students at baseline perceived themselves as being at risk for gaining excessive weight in the coming two years. Also, at baseline most students (88%) perceive that they can do something themselves to prevent gaining excessive weight. At baseline, a higher proportion of the students reported a positive subjective norm, intention and perceived internal control compared to follow-up.

Table 1 Perceptions about the prevention of excessive weight gain at baseline and at four-month follow-up (n=345)

Cognition	Baseline	Follow-up
Perceived weight (mean (SD))		
Lean (-2) – fat (+2)	0.03 (0.69)	0.02 (0.68)
Attitude (%)		
Positive	76.5	75.1
Neutral/negative	23.5	24.9
Subjective norm (%)		
Positive	62.0	52.8[a]
Neutral/negative	38.0	47.2
Perceived behavioural control (%)		
Positive	75.1	74.8
Neutral/negative	24.9	25.2
Intention (%)		
Positive	68.4	60.0 [a]
Neutral/negative	31.6	40.0
Risk perception (%)		
Positive (large)	14.2	15.7
Neutral/negative (small)	85.8	84.3
Perceived internal control (%)		
Positive	87.5	80.0 [a]
Neutral/negative	12.5	20.0

[a] indicates significant differences between baseline and follow-up; SD: standard deviation

Table 2 presents data on associations between potential determinants and intention to prevent excessive weight gain. The first model indicates that girls (Odds Ratio (OR)=1.66) and adolescents attending university preparatory education (OR=2.23) were more likely to have a positive intention to prevent excessive weight gain as compared to boys and vocational school students respectively. In model 2, the weight related variables were not significantly associated with intention, but the association of educational level became stronger and ethnicity became significantly associated, where adolescents from a Western background were more likely to have a higher intention. Model 3 indicates that positive attitudes (OR=2.52), subjective norms (OR=2.49) and perceived internal control (OR=4.04) and a higher educational level were associated with a positive intention to prevent gaining excessive weight. In this model, the effect of gender and ethnicity became insignificant.

Table 3 gives the results of the longitudinal analyses examining whether a change in possible determinants predicts a change in intention (analyzed as outcome at follow-up corrected for intention at baseline) over the four-month period. In model 1, with the distal variables, girls were more likely to increase their intention to prevent weight gain as compared to boys (OR=1.79). Adolescents with a higher

Table 2 Results from cross-sectional logistic regression analyses with change in intention between baseline and follow-up to prevent excessive weight gain as dependent variable and demographics, weight-related factors and change in cognitions as predictor variables n=345)

Predictor variable	*Model 1 (R^2=6.3%)*		*Model 2 (R^2=12.3%)*		*Model 3 (R^2=29.6%)*	
	OR (95% CI)		OR (95% CI)		OR (95% CI)	
Gender (girls=1; boys=0)	**1.82**	(1.14 – 2.91)	**1.66**	(1.03 – 2.69)	1.59	(0.94 – 2.70)
Education (higher=1; lower=0)	**1.86**	(1.16 – 2.97)	**2.23**	(1.36 – 3.65)	**2.34**	(1.34 – 4.07)
Ethnicity (non-Western=1; Western=0)	0.62	(0.36 – 1.07)	**0.49**	(0.27 – 0.86)	0.68	(0.36 – 1.28)
Perceived weight			1.55	(0.97 – 2.50)	1.33	(0.79 – 2.27)
BMI			1.10	(0.97 – 1.24)	1.06	(0.94 – 1.19)
Attitude (pos. vs. neg.)					**2.52**	(1.38 – 4.60)
Subjective norm (pos. vs. neg.)					**2.49**	(1.46 – 4.26)
PBC (pos. vs. neg.)					1.03	(0.53 – 1.97)
Perceived internal control (pos. vs. neg.)					**4.04**	(1.79 – 9.10)
Risk perception (large vs. small)					1.39	(0.60 – 3.24)

PBC = perceived behavioural control; pos. = positive; neg. = negative; OR = odds ratio; CI = confidence interval; R^2=explained variance, Nagelkerke R Square
Note: Betas in boldface indicate a significant association.

Table 3 Results from longitudinal logistic regression analyses with change in intention between baseline and follow-up to prevent excessive weight gain as dependent variable and demographics, weight-related factors and change in cognitions as predictor variables (n=345)

Predictor variable	*Model 1 (R^2=23.0%)*		*Model 2 (R^2=27.1%)*		*Model 3 (R^2=36.3%)*	
	OR (95% CI)		OR (95% CI)		OR (95% CI)	
Intention at 1st measurement (positive=1; neutral/negative=0)	**5.47**	(3.29 – 9.08)	**4.77**	(2.83 – 8.04)	**5.66**	(3.23 – 9.92)
Gender (girls=1; boys=0)	**1.79**	(1.11 – 2.89)	**1.68**	(1.03 – 2.74)	1.64	(0.98 – 2.77)
Education (higher=1; lower=0)	1.28	(0.79 – 2.07)	1.52	(0.92 – 2.51)	1.27	(0.74 – 2.17)
Ethnicity (non-Western=1; Western=0)	0.63	(0.35 – 1.11)	**0.52**	(0.28 – 0.95)	0.57	(0.31 – 1.08)
Perceived weight			**1.86**	(1.13 – 3.07)	**1.99**	(1.16 – 3.40)
BMI			1.02	(0.91 – 1.15)	1.02	(0.91 – 1.15)
Change in attitudes between measurements					**1.37**	(1.02 – 1.86)
Change in subjective norms between measurements					1.03	(0.85 – 1.24)
Change in PBC between measurements					1.09	(0.77 – 1.55)
Change in perceived internal control between measurements					**1.96**	(1.41 – 2.73)
Change in risk perception between measurements					0.93	(0.66 – 1.32)

PBC = perceived behavioural control; OR = odds ratio; CI = confidence interval; R^2=explained variance, Nagelkerke R Square
Notes: by correcting for baseline data the outcome can be interpreted as a change; Betas in boldface indicate a significant association.

perceived weight (OR=1.86) at baseline were more likely to increase their intention over the four-month study period (model 2). In model 2, ethnicity became significant, where adolescent from a Western background were more likely to

increase their intention. Adding the cognitions (model 3) showed that adolescents who increased their attitude (OR=1.37) or perceived internal control (OR=1.96) were more likely to increase their intention to prevent excessive weight gain. In this model, gender and ethnicity became insignificant.

Comparing the longitudinal (Table 3) and cross-sectional (Table 2) outcomes reveals that in both analyses attitude and perceived internal control had high odds ratios and were highly significant. Subjective norm was not significant in the longitudinal analyses as opposed to the cross-sectional analyses. A higher level of education was associated with a higher intention to prevent weight gain in the cross-sectional analysis, but did not predict an increase in intention over time. Perceived weight at baseline was a significant predictor of change in intention in the longitudinal analyses, but was not significant in the cross-sectional analyses.

DISCUSSION

Main findings

This is the first study to examine potential determinants of the intention of adolescents to prevent excessive weight gain in both cross-sectional and longitudinal analyses. The results showed that 60% of the students had a positive intention towards the prevention of excessive weight gain, while 16% perceived a high risk of gaining excessive weight. Furthermore, an increase in attitude and perceived internal control and a higher perceived weight predicted an increase in intention to prevent excessive weight gain over the four-month period. The cross-sectional and longitudinal results differed in several ways. Subjective norm and education were associated with intention, but were not predictors of change in intention. Inversely, perceived weight was a predictor of change in intention, but was not associated in the cross-sectional analyses. Attitude and perceived internal control were associated with intention in both analyses.

Interpretation and explanation of results

Globally, many governmental and non-governmental organizations recognize the urge to focus on children to stop the rise in obesity prevalence [2, 3]. This increasing public awareness about the importance of preventing overweight and obesity implies that we should also aim at better understanding what motivates adolescents to prevent excessive weight gain in order to inform possible interventions. This

study contributes to this understanding by studying a selection of factors that we hypothesized might be related to the intention to prevent excessive weight gain. To answer our main research question (identify psychosocial, weight related and demographic predictors of the intention to prevent excessive weight gain), we used a longitudinal design, in which changes over time can be studied. Studying changes in a set of potential predictor variables and associations with changes in a dependent variable (e.g., intention to prevent excessive weight gain) will provide stronger evidence for what variables to target in interventions aimed at modifying a variable of interest (e.g., intention or behaviour), as compared to studying associations between variables in a cross-sectional study. Modifying correlates identified in cross sectional analyses in interventions, may not result in desired changes in an outcome of interest, since it cannot be determined whether a variable predicts change. Therefore, we used the results from the longitudinal data for interpretation of the main research question. To illustrate potential differences between associations found in cross-sectional and longitudinal studies, we also presented results from cross-sectional analyses.

The only study that we can compare our results with, is a cross-sectional study on intentions to prevent weight gain among adults. In this study a significant relation with risk perceptions and attitudes was found [16], whereas we did not find this association for adolescents. It might be that risk perception is related to intention in adults but not in adolescents, because adolescents perceive risk differently.

We found strong evidence for the relation between attitudes and perceived internal control with intention to prevent excessive weight gain, since these variables showed significant associations with intentions in both the longitudinal and the cross-sectional analyses. Subjective norm was cross-sectionally associated with, but a change in subjective norm did not predict a change in, intention. Therefore, in order to try to influence intentions with interventions we may better focus on promoting positive attitudes and develop a stronger (sense of) internal control than on targeting subjective norms. Even though parental subjective norm may be associated, focusing on changing subjective norm is not likely to result in a change in intention. Future research might want to address the role of peer subjective norms.

The relation between perceived weight and intention was not significant in the cross-sectional analyses, but was significant longitudinally. So, adolescent who perceived their weight as higher did not have a more positive intention to prevent gaining weight at the start of the school year, but were more likely to adopt a

positive intention to prevent weight gain over the four-month period. Because the study population consisted of students who had just started their secondary education at the start of the study, it may be that adapting to their new school environment and related peer norms or pressure, may have resulted in this predictive association. Adolescents often misperceive their weight status: among normal weight adolescents, about 25% of the girls and 7% of the boys perceive themselves as being overweight [31]. Since perceived weight rather than actual weight predicted the intention to prevent excessive weight gain and perceived weight has been found to be related to weight control behaviours [32, 33], interventions should be aiming to increase adolescents' awareness of their weight status.

Education was not significantly associated with intentions in the longitudinal analyses, while it was in the cross-sectional analyses. This indicates that higher educated adolescents were more likely to have a positive intention towards weight gain prevention at baseline, but that there was no difference in change in intention between higher and lower educated adolescents. This means that lower educated adolescents, who also experience higher levels of overweight and obesity, maintain a more negative intention to prevent weight gain over the four month period as compared to higher educated adolescents. This implies that adolescents attending a lower educational level are an important population to promote a positive intention to prevent weight gain.

We found that about 60 to 68 percent of the adolescents were motivated to prevent excessive weight gain. A study from the United States showed that in 2001 the majority of girls report to try to lose weight (about 62%) or avoid gaining weight (about 16%), whereas these proportions are 29 and 22 % respectively for boys [34]. We also found that girls were more likely to be motivated to prevent weight gain and to increase their intention over a four month period as compared to boys. Part of this relation between gender and intention was explained by the weight-related variables and the cognitions, since gender became insignificant when the cognitions were added to the model. Future effect modification and subsequent stratified analyses by gender might provide more insight in gender differences in important correlates or predictors of intention to prevent excessive weight gain. The present study was underpowered to perform such analyses.

We studied the predictors of intention to prevent excessive weight gain. Although intentions are reported to be strongly predictive of actual behaviour, the 'intention-behaviour gap' has been demonstrated in many health behaviours, including those relevant for energy balance [11, 35, 36]. For weight gain prevention one of the reasons for a gap between intention and behaviour may be that adolescents are

unaware of what they have to do to prevent weight gain. A longitudinal study of the prediction of intention to prevent excessive weight gain on actual energy balance-related behaviours and weight would be a logical next step. The explained variance in the longitudinal model was 36%. Although this is a substantial proportion, much of the variance of change in intention must be explained by other factors not measured here. Recently, particularly factors from the physical and socio-cultural environment have been considered additions to the presumed psychosocial predictors of behaviours [37]. Kremers et al. have reported that such environmental factors may also predict behaviours via intentions [38]

In the present study, some methodological limitations imply that the results should be interpreted with caution. The predictors were assessed with a one-item measure (subjective norm, intention, perceived internal control) or with a two-item measure (attitude, perceived behavioural control, risk perception). These measures may have covered only part of the larger construct. For example, one's subjective norm towards the intention to prevent excessive weight gain may include not only an evaluation of parental norm, but also of friends. This might have led to less accurate response and therefore finding fewer or less strong associations. In the present study we did not include more items because the age group and classroom administration of the questionnaire obliged us to restrict the number of questions as much as possible. In addition, the reliability coefficients were fairly low for the two-item measures, although we need to consider that the Cronbach's alpha is sensitive to the number of items in the calculation. Our study sample was relatively small. When using larger samples other correlates or predictors with smaller effect sizes may become apparent. Furthermore, in this exploratory study, we did not perform separate analyses for boys and girls or higher and lower educated adolescents, while there may be differences. Future studies, with larger sample sizes could replicate this study and examine differences according to gender or education.

Conclusions

This study argues that to prevent overweight and obesity, positive intentions among adolescents to prevent excessive weight gain might be important. In this study a small majority had a positive intention to prevent excessive weight gain, while only few adolescents perceived they were at risk. This study seems to indicate that positive intentions are predicted by positive attitudes and perceived internal control. To our knowledge, this is the first study on intentions to prevent weight gain among adolescents. Therefore, these results need to be replicated and

implications for actual behaviour change need to be revealed. If these assertions hold true then stimulating positive attitudes and the perceived internal control to prevent excessive weight gain among adolescents might increase the intention to prevent excessive weight gain, which can help to prevent gaining too much weight during the early years of life. Adolescents engaging in a lower level of education have less intention toward prevention of excessive weight gain, while such adolescents are more likely to be overweight [39]. Therefore, adolescents from lower educational levels are a particularly important group to target. The results further indicate that longitudinal and cross-sectional analyses of data do not produce similar results. This confirms previous research, which builds a strong case that we need longitudinal studies in addition to cross sectional research to study predictors of healthful behaviour change.

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APPENDIX

Concepts, questions, answering categories and internal consistency between items of the questionnaire used

Cognition	Question	Answering scale (value)	Internal consistency (α)
Perceived weight	What do you think of your own weight; do you think you are fine, too lean or too fat?	Much too lean (-2) – much too fat (+2)	
	What do you think of yourself compared to others of your age and gender; do you think you are leaner or fatter than others?	Much leaner (-2) – much fatter (+2)	0.80
Attitude	I think preventing gaining fat is...	Very good (+2) – very bad (-2)	
	I think preventing gaining fat is...	Very important (+2) – very unimportant (-2)	0.53
Subjective norm	Do you think your parents want you to prevent gaining fat?	Most certainly (+2) – certainly not (-2)	
Perceived behavioural control	Do you think it is difficult or easy to prevent gaining fat?	Very difficult (-2) – very easy (+2)	0.59
	Do you think you will succeed in preventing gaining fat?	Most certainly (+2) – certainly not (–2)	
Risk perception	What do you think the chance is that you will gain fat in the coming two years?	Very high (+2) – very low (-2)	
	Do you think you have a larger or a smaller chance of gaining fat in the coming two years compared to others of your age and gender?	Much larger (+2) – much smaller (-2)	0.61
Intention	Do you intend to prevent gaining fat in the coming two years?	Most certainly (+2) – certainly not (–2))	
Perceived internal control	Do you think you can do something yourself not to gain fat?	Most certainly (+2) – certainly not (-2)	

Chapter 3

Do trends in physical activity, sedentary and dietary behaviours support trends in obesity prevalence in two border regions in Texas?

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ABSTRACT

Objective: The aim of the study was to compare the change in energy balance-related behaviours from 2000/2002 to 2004/2005 between two Texas regions with distinct patterns in obesity prevalence (decrease in El Paso region and levelling off in Rio Grande Valley region) and to determine the role of the behaviours in the difference in obesity prevalence between the regions.
Design: Two cross-sectional measurements of the School Physical Activity and Nutrition Study (SPAN)
Setting: Elementary schools in Texas
Participants: 3,949 children in 4th grade (9-10 year old)
Variables measured: BMI (objectively measured) and behaviours (self-assessed)
Analysis: Probability and post-stratification weighting procedures and mediation analysis
Results: Students in El Paso region experienced a lower decrease in sports team participation, an increase in regular meal consumption, and an increase in the frequency of milk/yoghurt, cereal, sweet snacks and frozen dessert consumption between measurement periods compared to students in Rio Grande Valley region. The prevalence of frequent television viewing was lower in El Paso region. The lower BMI in El Paso HSR was associated with regular meal consumption, higher milk/yoghurt and higher sweet snacks consumption.
Conclusions and implications: Maintenance of physical activity, lower levels of sedentary behaviours, and healthier dietary behaviours seem to be related to the decrease in obesity in El Paso region. However, unhealthy dietary behaviours like consumption of sweet snacks were not related to an increased risk for obesity.

INTRODUCTION

Childhood obesity rates in the United States have reached unprecedented proportion, with 17% of children found to be obese according to the NHANES surveys of 2003 to 2006 [1]. Hispanic girls and boys represent the ethnic group in the U.S. with among the highest rates of obesity, with a prevalence of 24% in children between the ages of 6 and 11 years [1]. In Texas, a state with one of the largest Hispanic populations in the United States, statewide prevalence estimates from 2000/2002 indicate that 30% or more of Hispanic boys and over 20% of Hispanic girls in 4th grade (mean age: 10 years old) are obese [2].

Statewide surveillance of obesity provides an important opportunity to assess changes over time while also comparing regions within a given state to better understand etiologic mechanisms of obesity and potential protective factors that may inhibit the increase in obesity. The School Physical Activity and Nutrition (SPAN) study is a population-based surveillance system that measures the prevalence of obesity and energy balance-related behaviours in Texas school children by Health Service Region (HSR) [2]. HSRs are geographic demarcations within the state of Texas used to administer health services. To date, the SPAN survey has been administered in 2000/2002 and 2004/2005, with a third measure planned for 2009.

In exploring further obesity trends within Texas, a recent analysis of SPAN data found that the prevalence of obesity in 4th grade students living in the HSR of El Paso, Texas, decreased by 7 percentage points, while obesity prevalence rates in other regions in Texas were maintained or increased [3]. In a demographically and geographically comparable region, Rio Grande Valley HSR, for example, obesity prevalence in 4th grade students increased between 2000/2002 to 2004/2005 from 25.8% to 30.6% (not significant) compared to a decrease in obesity prevalence in El Paso HSR 25.8% to 18.8% [3]. A comparison of El Paso HSR and Rio Grande Valley HSR may further our understanding of key energy balance-related behaviours that both contribute to and inhibit increases in childhood obesity.

A variety of physical activity, sedentary and dietary behaviours are likely to be related to overweight and obesity in children [4-6]. However, much of the evidence comes from cross-sectional studies, and there are many conflicting results. In general, the evidence for a negative association of regular physical activity, breakfast, and fibre, bread, grain and cereal consumption with overweight/obesity is convincing [4-6]. Sedentary lifestyle and sugar-sweetened beverage consumption is

convincingly positively related to overweight/obesity [4-7]. Snack consumption is most likely positively related to overweight/obesity [4, 5], although the relation between snack consumption and overweight and obesity seems rather complex, due to a possible moderating role for genetic or environmental risk factors [4]. Evidence of a positive relation between fruit juice consumption and overweight/obesity is inconclusive, at least partly due to differences in definition of fruit juice [4, 5], as is the evidence for milk/calcium intake [4]. To add new evidence to the existing literature, additional methods that examine the contribution of a variety of behaviours to obesity, are needed.

The objective of the present study was to compare the change in energy balance-related behaviours over the period 2000/2002 to 2004/2005 between the El Paso and Rio Grande Valley HSR. In addition to individual behaviours, composite scores were used to describe clusters of behaviours in order to assess patterns of healthy and unhealthy dietary, physical activity and sedentary behaviours. The second aim was to determine if the difference in obesity prevalence between the two regions was associated with physical activity, sedentary or dietary behaviours by using mediation analysis.

METHODS

Study Design and Participants

Design, sampling and measurement details about the SPAN study have been previously reported and are only briefly presented here [2, 3]. The SPAN study was designed to provide representative estimates of child weight status and energy balance-related behaviours at both the state level and the Texas Department of State Health Services regional level [2]. Texas is divided into eight HSRs by the Texas Department of State Health Services [8]. For this paper, we examined data from 3,949 4th grade children (9 to 10 years old) from the El Paso HSR and the Rio Grande Valley HSR.

Although SPAN data are available for all eight regions of the HSRs of Texas, only two HSRs (El Paso HSR 9-10 and Rio Grande Valley regions HSR 11) are compared in this paper for several reasons. First, both regions have similar demographics in terms of their proximity to the Texas border and their majority Latino/Hispanic population. This is important because overweight/obesity levels among Hispanics are higher than among Whites [2], and there are many cultural differences in eating

and physical activity behaviours between Hispanics and Whites [9]. Second, adult residents in Texas-Mexico border areas are more likely to have increased physical health problems [9, 10] and less access to health care [11] than in other areas of Texas or nationally. These characteristics may be similar for children. Finally, the El Paso HSR has had several major community health promotion initiatives during the periods covered by the SPAN survey [12-14], while the Rio Grande Valley efforts have been more modest. These differences in health promotion activity provide an opportunity to evaluate potential differences in energy balance-related behaviours.

Approval for this study was obtained from the Committee for the Protection of Human Subjects at the University of Texas Health Science Center at Houston, HSC-SPH-00-056, the Institution Review Board of the Texas Department of State Health, 04-062, and the participating school districts. Parental consent was obtained before participation in the study; students with parental consent completed an assent form prior to administration of the SPAN questionnaire at the school.

Sampling

For the first measurement, Rio Grande Valley HSR was surveyed in school year 2000/2001 and El Paso HSR in school year 2001/2002. For the second measurement, both HSRs were surveyed in school year 2004/2005. The sampling frame included all public schools in Texas. Schools were selected from urban centre, urban/suburban, and rural school districts from each Health Service Region of Texas [2, 3]. At least two representative classes per school were selected to provide samples of 50 students. Overall participation rate was 80%. Further details on the sampling design and methods have been provided in previous publications [2, 3].

The final sample for El Paso HSR at measurement period 1 consisted of 24 schools with 1,161 students. At measurement period 2, the final sample consisted of 20 schools with 786 students. The final sample for Rio Grande Valley HSR at measurement period 1 consisted of 13 schools with 818 students; at measurement period 2, the sample consisted of 26 schools with 1,184 students. Participation rates for the El Paso HSR were 77.4% and 100% for 2000/2001 and 2004/2005; participation rates for the Rio Grande Valley HSR were 100% at both time periods.

Procedure

School districts selected for the sample were contacted by study staff and invited to participate. Individual schools were contacted once district approval and consent

to participate were obtained. Trained and certified study, state and county personnel conducted data collection. Questionnaires were distributed through the main SPAN study office, and completed questionnaires were sent to the SPAN office for scanning for cleaning and quality control.

Measures

The questionnaires, adapted from the School-Based Nutrition Monitoring (SBNM) survey, were administered to study participants and have been evaluated for reliability (dietary and physical activity questions) and validity (dietary questions) [15-17]. These questionnaires were designed as epidemiologic survey tools to assess nutrition and physical activity behaviours, nutrition knowledge, and nutrition attitudes. Demographic data for the students such as age, race/ethnicity and gender, were self-reported. The percentage of economically disadvantaged students was assessed at the school level and was based on classifications provided from the Texas Education Agency. For analytic purposes race/ethnicity was classified as African American, Hispanic/Latino, White, or Other. Copies of the questionnaire can be found at: http://www.sph.tmc.edu/dellcahl/default.asp?id=2205.

Dietary behaviours were generally assessed over the previous day with a modified Food Frequency Questionnaire format, using a four-point scale that included the following response options: none, one time, two times, and three or more times. Behavioural items, reference period and response categories are presented in the appendix.

Measurement of height and weight were conducted using standard protocols and recorded directly on the questionnaire form after the students completed the written items. Height and weight were used to calculate body mass index (BMI), using the standard formula. Students were classified obese ($\geq 95^{th}$ percentile for age and gender), overweight ($\geq 85^{th}$ percentile, but $<95^{th}$ percentile) or normal weight ($<85^{th}$ percentile) according to the U.S. Centers for Disease Control and Prevention Growth Charts [18].

Data analysis

A total of 252 cases (1% of total) were excluded from the dataset, and a total of 510 logical and mean imputations were made for variables such as birthday, age, ethnicity, height and weights. A more detailed breakdown of the exclusions, inclusion and imputations are described elsewhere [3]. Sampling probability

weights were calculated to account for differential inclusion probabilities in the multistage sampling. Sampling weights were the inverse of selection probability that encompassed the sampling ratio at each stage of selection. Post-stratification weights adjustments were made to ensure ethnic, gender and urbanization composition in the sample was the same as the total school enrolment in each HSR in the sampling frame. Sample design features (stratification of the sample and clustering of students within schools) were accounted for in weighting estimates and performing statistical tests. The survey analysis module (svy) of STATA (version 10, 2009, College Station, Texas) was used to calculate proportions and regression analysis using Taylor series linearization. Alpha was set at .05. S-PLUS (version 6.0, 2001, Insightful Corp.) was used for the bootstrapping.

Descriptive analyses of the students' characteristics were performed within strata for HSR and measurement. Chi square test (proportions) and t-test (means) were used to test for differences between HSRs and between measurements. Proportions for the behaviours within the two strata for region and for both measurements were calculated. Net differences and confidence intervals were calculated. By running logistic regression models with HSR, measurement and the interaction term HSR*measurement, we obtained P-values to compare differences between the HSRs over time (P-value for the interaction) and to compare differences between HSRs (P-value for HSR). The cut-off point for significance was set at .05 and for the interaction term was set at .1. Composite scores were developed to look at a combination of behaviours within persons. Four composite scores were calculated: healthy foods (fruit, vegetables, milk, yoghurt, bread, cereal, rice/pasta, peanuts/peanut butter, ranging from 0 to 27), unhealthy foods (sweet snacks, chocolate, fries/chips, soda, fruit-flavoured drinks, ranging from 0 to 15), sedentary behaviours (TV watching, gaming, ranging from 0-7), and sports (PE class, sports teams, organized sports, ranging from 0 to 9). Using composite scores made it possible to describe behavioural patterns instead of only looking at single behaviours. By doing so we could see if the consumption of healthy food, unhealthy foods, sedentary behaviours and sports activities showed trends over time. Studying patterns of food intake and physical activity was important because certain foods or doing multiple sports might cluster within students. Examination of food and activity patterns provided a better representation of a healthy diet or active lifestyle as compared to focusing solely on one food or physical activity behaviour, especially when using questionnaire items that target one day of consumption. Another reason for looking at composite scores was that students might have substituted certain foods with other foods over time, e.g. less frequent soft drink consumption over time might go along with a more frequent intake

of fruit-flavoured drinks over time. Since we used the composite score here to identify general food patterns that might be related to obesity, we did not intend to claim that, for instance, the healthy foods could be regarded as healthy in every way. In addition, overconsumption of any food could have adverse health effects. Composite scores were computed as frequencies at both time points for both regions.

Cross-sectional mediation analysis, following the product-of-coefficients test [19], was used to determine if the differences in BMI between regions at the 2004/2005 measurement were associated with the behaviours at first measurement. A behaviour was said to be a mediator or 'associated with' if: 1.) HSR had a statistically significant effect on the behaviour (a coefficient); 2.) the behaviour was associated with BMI, after controlling for HSR (b coefficient); 3.) significance of the mediated effect (product of the a and b coefficients) was determined using bootstrapping. Because the product of two coefficients is not normally distributed, the z-test cannot be used. An alternative approach is bootstrapping, where instead of using the normal distribution, the empirical distribution of the observed data is used to determine the confidence interval around an estimate. So, a sample with replacement is drawn 1000 times from the original study sample. In each new sample the mediated effect, a*b, is estimated. The mediated effect estimated in each bootstrap sample is used to form a distribution of the bootstrap mediated effect estimates, and confidence limits are obtained from the bootstrap distribution. Using the distribution of mediated effect estimates, the 95% confidence limits of the mediated effect are then the values of the mediated effect at the 2.5^{th} and 97.5^{th} percentiles in the distribution of bootstrapped mediated effects [19]. Important benefits of bootstrapping include the fact that it has no distributional assumptions, that the technique has high statistical power and is highly accurate in estimating Type I error rates. Percentage mediated effect was calculated as ab/c, where c is the coefficient in the relation between BMI and HSR.

RESULTS

Demographic characteristics of the students for both measurements and between HSRs are shown in Table 1. Significant differences were present between weight categories over time in Rio Grande Valley and between regions in measurement period 2004/2005. Race/ethnicity differed between regions in both time periods. The majority of the students in both regions was Hispanic (74-90%) and between 19 and 31 percent of the students were obese based on CDC definitions.

Table 1 Demographic characteristics of 4th grade students in El Paso and Rio Grande Valley Health Service Regions in Texas at measurements 2000/2002 and 2004/2005

	Texas Health Service Region			
	El Paso		Rio Grande Valley	
	2000/2002	2004/2005	2000/2002	2004/2005
No. of students: n	1161	786	818	1184
Gender (% boys)	51	51	51	51
Race/ethnicity (%) [a]				
Hispanic	74	80	87	90
African American	3	2	1	1
White	11	8	7	3
Other	11	10	4	6
Average % economically disadvantaged students at school level	70	82	76	83
Age (mean+/-SD)	9.7 (0.04)	9.7 (0.05)	9.7 (0.02)	9.7 (0.05)
Weight category [c] **(%)**[b]				
Healthy	60	64	59	49
Overweight	14	18	15	20
Obese	26	19	26	31

[a] Race/ethnicity differed between regions in both time periods

[b] Weight categories differed over time in Rio Grande Valley and between regions in measurement period 2004/2005

[c] Weight category according to CDC standard

Table 2 presents the proportion of students that reported the dietary, sedentary and physical activity behaviours at first and second measurements for both HSRs. In addition, differences between measurement 2004/2005 and 2000/2001 are shown with their confidence intervals. Based on regression analyses for each behaviour with HSR, measurement and interaction between measurement*HSR as dependent variables, the P-values for the HSR and the interaction variables are shown. The P-value for HSR indicates if the absolute proportion of students who perform a behaviour differs between regions. The P-value for the interaction term indicates if there is a difference between the HSRs over time.

Physical activity

Table 2 shows that, in general, the number of days when students were vigorously active for at least 20 minutes per day increased in both regions as did the number of physical education classes that the students attended. These two variables were likely to overlap, since part of the physical education classes will consist of vigorous physical activity. Participation in sport teams decreased in Rio Grande Valley HSR. This decrease was more pronounced in girls (-13%) than in boys (-5%) (data not shown in tables). If we look at the composite scores (figure 1), the times participated in any sports activities, in and outside the school,

Table 2 Self-reported physical activity, sedentary behaviours and dietary behaviours of 4th grade students in two Texas Health Services Regions (HSR) at measurements 2000/2002 and 2004/2005

	El Paso HSR[a]				Rio Grande Valley HSR[a]				p-value[b]	p-value[b]
	00/02	04/05	Change	95% CI[c]	00/02	04/05	Change	95% CI[c]	b-coefficient for HSR	Interaction
Physical activity										
≥ 3 days VPA[d] per week	84%	94%	**10%**	7% - 13%	82%	92%	**9%**	6% - 12%	0.384	0.531
≥ 3 days attending physical education class per week	65%	74%	**9%**	4% - 13%	46%	54%	**7%**	2% - 12%	0.184	0.933
≥ 1 sports teams	76%	75%	0%	-5% - 4%	82%	74%	**-8%**	-12% - -5%	0.107	**0.095**
taking part in other organized physical activity	45%	46%	1%	-3% - 6%	44%	40%	-4%	-9% - 0%	0.766	0.132
Sedentary behaviours										
>2 hours TV viewing yesterday	22%	27%	4%	0% - 8%	31%	39%	**9%**	4% - 13%	**0.009**	0.898
>2 hours gaming yesterday	12%	21%	**9%**	6% - 13%	11%	21%	**10%**	6% - 13%	0.848	0.936
Dietary behaviours										
eat breakfast	82%	87%	**6%**	2% - 9%	75%	79%	3%	-1% - 7%	0.221	0.389
≥ 3 meals yesterday	60%	61%	1%	-4% - 5%	63%	47%	**-16%**	-20% - -11%	0.296	**0.005**
≥ 2 times milk or yoghurt yesterday	50%	58%	**8%**	3% - 13%	41%	43%	2%	-3% - 7%	**0.034**	**0.069**
≥ 1 time bread yesterday	69%	71%	2%	-2% - 6%	71%	70%	0%	-4% - 4%	0.603	0.454
≥ 1 time cereal yesterday	47%	55%	**8%**	3% - 12%	46%	40%	**-5%**	-10% - -1%	0.894	**0.067**
≥ 1 time rice, pasta or noodles yesterday	38%	38%	0%	-4% - 5%	37%	36%	-1%	-5% - 4%	0.940	0.798
≥ 2 times fruit yesterday	31%	34%	3%	-2% - 7%	31%	33%	2%	-3% - 6%	0.522	0.705
≥ 1 time vegetables yesterday	61%	61%	0%	-5% - 4%	55%	57%	2%	-3% - 7%	0.409	0.819
≥ 1 time sweet snacks yesterday	56%	64%	**8%**	3% - 12%	66%	55%	**-11%**	-16% - -6%	0.236	**0.055**
≥ 1 time frozen dessert yesterday	36%	42%	**7%**	2% - 11%	50%	36%	**-14%**	-19% - -10%	0.152	**0.081**
≥ 1 times fries or chips yesterday	57%	58%	2%	-3% - 6%	67%	58%	**-10%**	-14% - -5%	0.307	0.375
≥ 1 time soda yesterday	57%	47%	**-11%**	-15% - -6%	60%	51%	**-8%**	-13% - -4%	0.584	0.966
≥ 1 time fruit-flavoured drinks yesterday	55%	61%	**6%**	1% - 11%	60%	57%	-3%	-8% - 1%	0.339	0.141
≥ 1 fruit juice yesterday	58%	60%	3%	-2% - 7%	60%	57%	-2%	-7% - 2%	0.826	0.601

Numbers in bold are statistically significant; [a] HSR = health service region; [b] p-values for the difference in the behaviour (linear) and the difference in trend over time (slope: interaction HSR*measurement) between the HSRs; [c] 95% Confidence Interval of net change over time; [d] VPA = vigorous physical activity

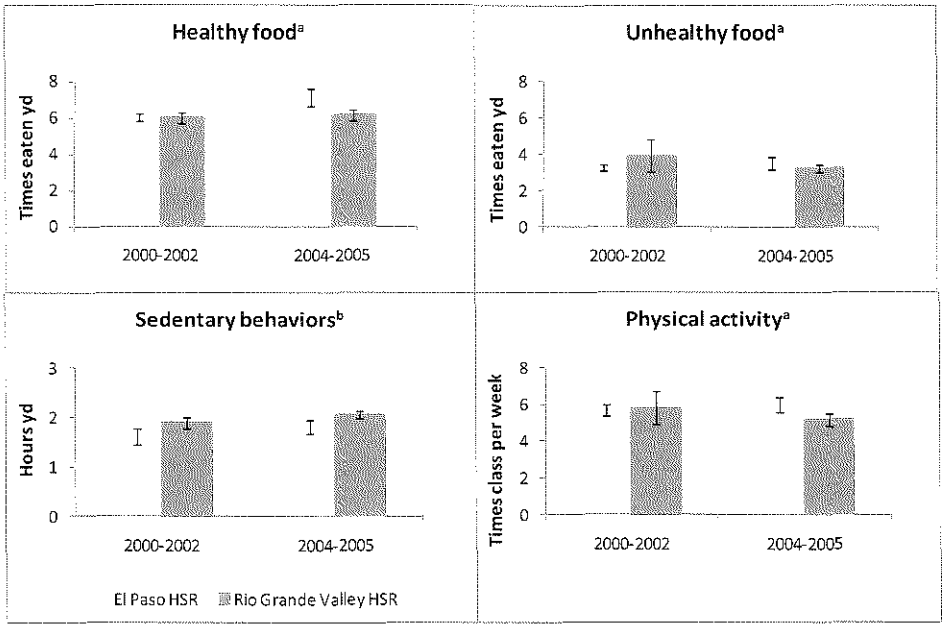

Figure 1 Change between 2000-2002 and 2004-2005 in sum scores for healthy, unhealthy, sedentary and physical activity behaviours of 4th grade students in two Texas Health Services Regions at measurements 2000-2002 and 2004-2005. (Healthy food: fruit, vegetables, milk, yoghurt, beans, bread, cereal, rice/pasta, peanut butter. Unhealthy food: soda, fruit-flavoured drinks, fries/chips, sweet snacks (cinnamon rolls etc), chocolate. Sedentary behaviour: TV viewing, gaming. Physical activity: number of PE classes, number of sports teams, organized sports (1/0)). HSR = Health Service Region; yd = yesterday. [a]Trend (slope) of healthy food, unhealthy food and physical activity differs significantly between the HSRs ($P < .05$) [b]Hours of sedentary behaviour differs significantly between HSRs ($P < .05$)

decreased by almost 1 time per week in Rio Grande Valley HSR as compared to El Paso HSR.

Sedentary behaviours

The percentage of students who played video games for more than two hours on the previous day increased from 10% to 20% of children (table 2). This large increase was observed in both regions and is accompanied by an increase in television viewing, predominantly in Rio Grande Valley HSR, where the percentage of students watching more than two hours of television yesterday increased from 31% to 39%. This increase was totally attributable to an increase of 17% among girls (vs. +0% among boys; data not presented in table). Absolute levels of television viewing were higher in Rio Grande Valley HSR as compared to El Paso HSR (P=.009). The composite scores show that the combined television and gaming time went up in both regions with about 20 minutes per day, but is at

both time points about 20 minutes higher in Rio Grande Valley HSR (figure 1) as compared to El Paso HSR.

Dietary behaviours

Table 2 shows a decrease in the number of students that drank at least one soda consumption per day between 2000/2002 and 2004/2005 of 8 percentage points in Rio Grande Valley HSR and 11 percentage points in El Paso HSR. Simultaneously with the decrease in soda consumption, there was an increase of 6 percentage points in the number of students that consumed at least one fruit-flavoured drink the previous day in El Paso HSR, but not in Rio Grande Valley HSR. A significant decrease in the number of students who ate at least one sweet snack or frozen dessert a day was found in Rio Grande Valley HSR, whereas in El Paso HSR the frequency of intake increased for sweet snacks and frozen desserts. Large differences were found between boys and girls in Rio Grande Valley HSR for the consumption of the following foods: soda (boys -3% vs. girls -14%), fruit-flavoured drinks (boys +13% vs. girls -18%), sweet snacks (boys -6% vs. girls -16%), frozen desserts (boys -2% vs. girls -26%), and fries/chips (boys -5% vs. girls -14%) (data not presented in tables).

Meal patterns differed considerably between both regions. The percentage of students who consumed at least three meals per day decreased by 16 percentage points in Rio Grande Valley HSR, but did not change in El Paso HSR. The number of students who consumed cereal at least one time a day increased by 8 percentage points among students from El Paso HSR, whereas in Rio Grande Valley HSR this decreased by 5 percentage points. The increase in the frequency of cereal consumption in El Paso HSR parallels an increase in the food intake it is most frequently combined with, i.e. milk and yoghurt (an 8 percentage point increase from eating <2 times to ≥2 times milk or yoghurt yesterday).

Composite scores for healthy and unhealthy foods show students' patterns in consumption of a combination of foods, taking into account substituting of behaviour over time and giving a sum of healthy or unhealthy foods. Figure 1 shows that in El Paso HSR there was a strong increase in frequency of healthy food consumption with over 1 time per day compared to the Rio Grande Valley HSR. For unhealthy food consumption, the frequency of intake on the previous day in El Paso HSR increased by approximately 0.5 times per day, whereas in Rio Grande Valley HSR the frequency of consumption decreased by almost one time per day. At the second measurement students in Rio Grande Valley HSR had slightly less unhealthy food eating occasions per day.

Mediation Analysis

In the relation between HSR and BMI, where the BMI at measurement 2004/2005 is higher in Rio Grande Valley HSR, the possible role of physical activity, sedentary and dietary behaviours was assessed. Possible mediators that were significantly associated with HSR (a coefficient) and were significantly associated with BMI when controlled for HSR (coefficient b) were assessed for significant mediation (figure 2). Consuming milk or yoghurt more than two times per day, three or more meals per day and more than one sweet snack per day were significant variables in the relation between HSR and BMI. Each of these variables explained approximately 25% of the relation between HSR and BMI. Thus, for each behaviour, 25% of the difference in BMI between the regions was explained by differences in this behaviour. There was no collinearity between these variables, so the explained variance for each behaviour does not overlap the explained variance of the other behaviours.

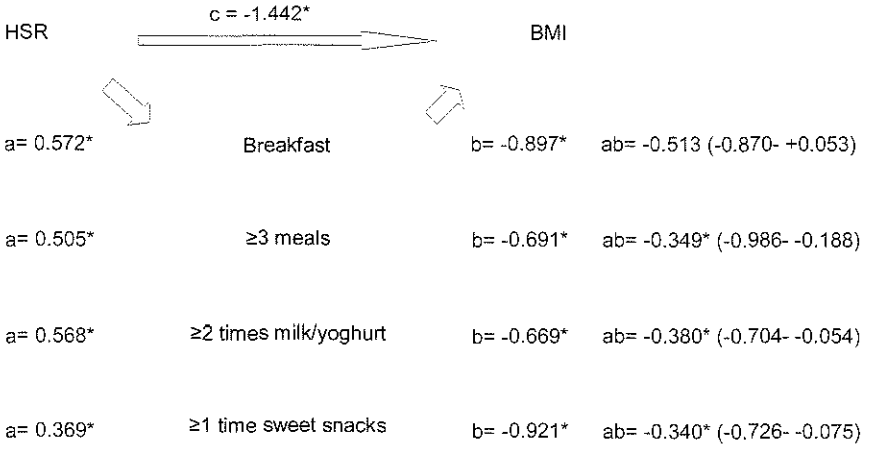

Figure 2 Mediation analysis at measurement 2004/2005. The a coefficients are from logistic regression analysis, whereas b and c are coefficients from linear regression analysis. Only mediators that had significant a and b coefficients are used in these mediation models. HSR=Health Service Region; BMI=Body Mass Index; * indicates significant effect; between brackets are 95% confidence interval

DISCUSSION

Principal findings

This study aimed to compare trends in energy balance-related behaviours between 2000/2002 and 2004/2005 in El Paso and Rio Grande Valley HSR and to assess

whether these behavioural trends accompanied obesity trends that were described earlier for these regions [3]. The second aim was to determine if the difference in obesity prevalence between the two regions was associated with physical activity, sedentary or dietary behaviours by using mediation analysis.

Explanation of results

In the same time period as our study, the El Paso HSR showed a decrease of obesity prevalence of seven percentage points, while Rio Grande Valley HSR showed a four percentage point increase in obesity prevalence [3]. One would expect an improvement in energy balance-related behaviours in El Paso HSR as compared to Rio Grande Valley HSR during this same time period, as the behaviours we studied are considered to be related to overweight and obesity (vigorous physical activity, physical education class, sports team, organized physical activity, TV viewing, gaming, breakfast, number of meals, milk/yoghurt, bread, cereal, rice/pasta/noodles, fruit, vegetables, sweet snacks, frozen dessert, fries/chips, soda, fruit-flavoured drinks, fruit juice) [4-6, 20-24]. Our results show that in El Paso HSR the following behaviours were healthier than in Rio Grande Valley HSR or improved more between the measurements: number of sports teams, television viewing, number of meals, milk/yoghurt consumption, and cereal consumption. In addition, the mediation analysis indicated that the lower BMI in El Paso HSR was associated with regular meal consumption and higher milk/yoghurt consumption. These results might suggest a protective role for sports team participation, limited television viewing, three or more meals per day, two or more portions of milk/yoghurt, and one or more times cereal per day. Reviews on the relation between behaviours and obesity confirm the role of television viewing [21, 23-27], sports teams [20], and cereals [4]. There is mixed evidence of milk consumption[4], and evidence for the number of meals per day is unclear due to differences in definitions of meals/eating moments and inverse causality.

One finding that is difficult to interpret was the reported decrease in sweet snack and frozen dessert consumption in Rio Grande Valley HSR and increase in sweet snack and frozen dessert consumption in El Paso HSR, with mediation analyses indicating that sweet snack consumption was associated with lower BMI. One explanation for this unexpected result could be that people with obesity tend to underreport consumption of foods, especially snack food [28, 29]. It is possible that students in Rio Grande Valley HSR, which has a higher prevalence of obesity, may underreport sweet snack and frozen dessert consumption. Another explanation might be that consumption of snacks or frozen desserts is not necessarily related

to an unhealthy diet. We also speculate that children in El Paso in general might have a more healthy lifestyle (more sports, less TV, three meals per day, healthy foods like dairy and cereal) with also an occasional snack or frozen dessert (e.g. milk and an oatmeal cookie after sports), while in Rio Grande Valley HSR snacks and frozen desserts are part of a general unhealthy lifestyle (e.g. a candy bar after school hours). Given a generally healthier lifestyle, these children may be more forthcoming in their reporting on consumption of sweet snacks. A third explanation might be that we assessed number of times a student ate snacks or frozen dessert and used the dichotomized variable (yes/no). Using the amount consumed might be a more sensitive outcome. So, for instance eating king size portions or eating ten times a day would not be distinguished by our measure from eating small portions or eating two times a day a snack of frozen dessert. This might conceal certain more extreme snacking behaviour.

Our results also show that the behaviours reported by children in El Paso HSR were healthier at baseline than those reported by children in the Rio Grande Valley HSR. The trend in obesity prevalence in El Paso HSR might be partially explained by these baseline healthier behaviours that affected the BMI at the latter measurement. As such, obesity prevalence in El Paso HSR could be reduced by a combination of healthier behaviours at baseline plus the improvement in healthy behaviours over time.

We found no difference in fruit and vegetable consumption between the regions, indicating that fruit and vegetable consumption might have a limited relationship to child obesity, especially as measured by these surveillance methods. In two papers (one review; one study) no relation between fruit and vegetable consumption and obesity was found either [4, 20]. On the other hand, a tracking study found a relation between vegetable consumption and sum of skinfold and BMI and between fruit consumption and sum of skinfold (but not with BMI) [22]. Further research is needed to understand the role of fruit and vegetable consumption as related to obesity prevention. Particular interest should be given to substitution of food groups (e.g. fruit versus snacks).

While our study design does not permit us to identify the causal mechanism for the change in obesity during this study period, several school and community health promotion activities that took place during this time may provide insights into possible directions for future research and intervention. During this time, several large-scale obesity prevention and healthy eating and physical activity promotion interventions took place in predominantly El Paso HSR, including dis-

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Appendix Questionnaire design: reference period and answering categories that were used to measure the behaviours of the students (9-10 year) in 2000/2002 and 2004/2005

Behaviour questioned	Reference period of the question	Answering format*
milk (including chocolate and other flavoured milk and milk on cereal)	previous day	four-point scale
yoghurt/cottage cheese (the milk and yoghurt questions were combined in one category: milk plus yoghurt)	previous day	four-point scale
peanuts/peanut butter	previous day	four-point scale
rice/macaroni/spaghetti/pasta noodles	previous day	four-point scale
bread/buns/bagels/tortillas/rolls (in 2004/2005 questionnaire asked as two questions: white and whole wheat – these two questions were combined to compare with the 2000/2002 question)	previous day	four-point scale
cereal (hot or cold)	previous day	four-point scale
French fries/chips	previous day	four-point scale
vegetables (including cooked, uncooked, salads, potatoes)	previous day	four-point scale
beans	previous day	four-point scale
fruit	previous day	four-point scale
fruit juice (100%)	previous day	four-point scale
punch/Kool-Aid/sports drinks/other fruit-flavoured drinks	previous day	four-point scale
soda/soft drink (in 2004/2005 questionnaire asked as two questions: regular and diet (the question on regular soda intake was used to compare with the 2000/2002 question)	previous day	four-point scale
frozen dessert	previous day	four-point scale
chocolate candy	previous day	four-point scale
sweet rolls/doughnuts/cookies/brownies/pies/cake (this question was combined with chocolate candy into sweet snacks)	previous day	four-point scale
number of meals	previous day	four-point scale
number of sports teams	previous day	four-point scale
breakfast	previous day	yes/no
organized physical activity	previous day	yes/no
hours television viewing	previous day	seven-point scale
hours playing video games	usually per day	seven-point scale
physical education class	past-week	seven-point scale
vigorous physical activity (asked as physical activity that made your heart beat fast and made you breathe hard for at least 20 minutes)	past-week	seven-point scale

* a four point scale consists of the following answering categories: none, one time, two times, and three or more times

Chapter 4

Cognitive and home environmental predictors of change in sugar-sweetened beverage consumption among adolescents

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ABSTRACT

Sugar-sweetened beverage (SSB) consumption may increase risk for excessive weight gain. To develop interventions discouraging consumption, more insight is needed about cognitive and environmental predictors related to the decrease of SSB consumption. This paper aims (1) to describe the relationship between potential cognitive determinants of change (attitudes, subjective norms, perceived behavioural control, intentions) and perceived environmental factors (family food rule and home availability of SSB) with changes in SSB consumption between baseline and four month follow-up and (2) to study whether the relationships between the environmental factors and SSB consumption are mediated by the cognitive determinants. Information on possible predictors and SSB intake at baseline and four month follow-up was provided by 348 Dutch adolescents (ages 12-13) through online questionnaires that were completed at school. Multilevel logistic regression and mediation analyses were used to determine direct and indirect associations between predictors and behaviour. Our results show that a high perceived behavioural control to decrease intake at baseline was associated with a decrease in consumption of sugar-sweetened beverages between baseline and follow-up (OR=0.53). Low availability and a stricter family food rule were associated with a decrease in SSB consumption between baseline and follow-up (OR=2.39; OR=0.54). The association between availability and decrease in SSB consumption was for 68% mediated by perceived behavioural control to drink less. In conclusion, interventions to decrease SSB intake should focus on improving attitudes and perceived behavioural control to reduce intake, and on limiting home availability and stimulating stricter family food rules regarding SSB consumption.

INTRODUCTION

Sugar-sweetened beverage (SSB) intake has been associated with an increased risk for overweight and obesity [1, 2]. High SSB intake is very common among adolescents [3-6]. Estimates range from half to one litre of soft drink consumption on average per day [3-5] with a frequency of almost five days per week [6]. In the past decades there has been an increase in SSB consumption among adolescents worldwide [5, 7, 8]. Therefore, to prevent the development of overweight and obesity among adolescents, decreasing the consumption of SSBs is an important target in behavioural interventions. To be able to develop effective interventions aimed at lowering SSB intake, a detailed understanding of the determinants of this specific behaviour among adolescents is needed [9]. Specifically, more knowledge about the determinants of improving a behaviour (e.g. decrease SSB consumption) as opposed to determinants of a healthy behaviour (e.g. little SSB consumption) is needed.

The Theory of Planned Behaviour (TPB) is one of the most widely used models in studying potential determinants of health behaviours, including dietary behaviours [10]. The theory postulates that a behaviour is predicted by an intention to engage in this behaviour, and that this intention is determined by attitudes (perceived pros and cons of the behaviour), subjective norm (perception of important others' expectations regarding the behaviour), and perceived behavioural control (perceived difficulty to engage in the behaviour) [11]. Some cross-sectional and one longitudinal study have used the TPB to explore possible determinants of SSB intake [4, 5, 12-16]. For SSB consumption, consistent relationships were found with attitude, subjective norm and intention whereas the relationship between perceived behavioural control and SSB consumption was less consistent.

The EnRG framework (Environmental Research Framework for Weight Gain Prevention) is a framework that posits clear mediation and interaction between cognitive and environmental determinants of energy balance behaviours [17]. Environmental influences are hypothesized to influence behaviour either directly or indirectly via cognitions. To increase our understanding of the mechanisms between environmental and cognitive determinants, the mediating role of cognitive factors in the relationship between environmental factors and behaviour is currently an important target in behavioural research. The home food environment may be of specific importance for adolescents, since adolescents consume a lot of SSBs at home [18]. Both the availability of SSBs and the family food rules for consumption of SSB provide specific conditions that might influence SSB

intake at home. Therefore, availability (i.e. the physical environment) and family food rules (i.e. a political factor) have been studied as possible correlates of SSB consumption in some studies (mostly cross-sectional; 1 longitudinal) [4, 14-16, 19, 20], providing evidence that such factors may indeed be of additional importance. Studies are now needed that investigate potential cognitive and environmental factors together, and preferably in longitudinal research [21].

The purpose of this study was to use longitudinal data to identify cognitive and environmental predictors of changes in SSB consumption among adolescents over a four month period. The cognitive measures were derived from the TPB and included attitudes, subjective norms, perceived behavioural control and intention toward reducing the intake of SSB. The environmental variables included availability and the family food rule at home regarding SSB consumption. In addition, we explored whether the effect of the environmental factors on SSB consumption was mediated by the cognitive factors (attitudes, subjective norms, perceived behavioural control and intentions) in the pathway between environmental factors (availability and family food rule) and change in behaviours (intake of SSB). The conceptual framework is shown in figure 1.

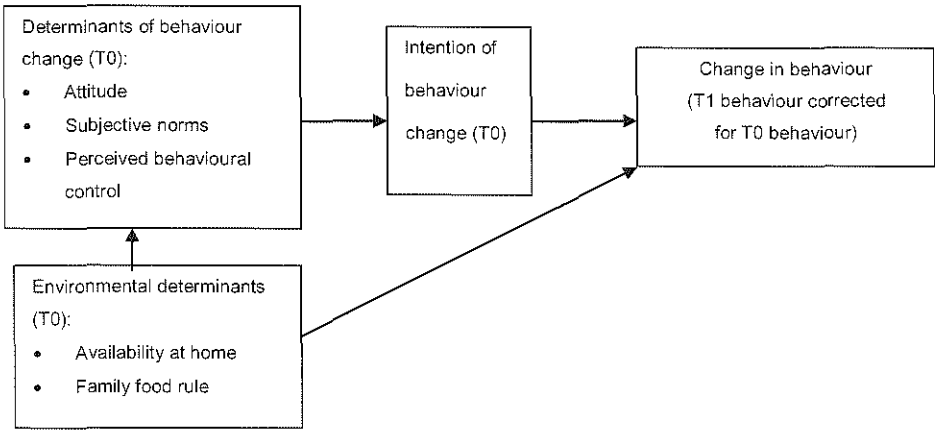


Figure 1 Conceptual framework

METHODS

This paper used longitudinal data of the FATaintPHAT intervention study for secondary analysis. FATaintPHAT is an intervention study that targets adolescents to prevent excessive weight gain through changes in energy balance-related behaviours. The study design and intervention are described thoroughly elsewhere[22].

In the present study, control group data regarding SSB intake and determinants from baseline and four month follow-up were used.

Study design and participants

Twenty schools for secondary education in Rotterdam and surrounding area's provided consent to participate in the FATaintPHAT study of which nine control schools were randomly assigned to the no intervention control group. Data from this group was used for the present study. Approximately four classes per school were randomly selected to participate in the study. During school year 2006-2007 baseline (November till February) and four month follow-up (March till June) measurements were conducted among adolescents aged 12 to 13 year (first grade). In the Netherlands, schools for secondary education vary by educational level, ranging from lower vocational to university preparatory. Schools varying from vocational level up to university preparatory level participated in this study. The study sample consisted of 398 students. The response rate was 56%.

Procedure

At baseline and follow-up, electronic, self-administered questionnaires were administered to the students and used to assess intake of SSB, students' personal cognitions and perceived environmental factors. Questionnaires were administered during a classroom lesson (about 45 minutes) under supervision of a research assistant. To increase participation rates, mp3-players were raffled at the end of the study among students who had completed all measurements.

Measures

Sugar-sweetened beverage intake

SSBs were defined as carbonated soda, non-carbonated sugar-sweetened drinks, and sport drinks. Frequency ("on how many days of the last 7 days did you drink SSB?") and quantity ("on a day you drank SSB, how much did you consume on average on a single day?" of SSB was assessed; answer categories for quantity were number of glasses (200ml), cans (333ml) and bottles (500ml)). Total daily SSB consumption was calculated as the average intake in millilitres per day. The food frequency questionnaire that we used is based on a validated questionnaire [23, 24] and is frequently applied for assessing SSB intake among adolescents [5, 25]. The ten-day test-retest reliability was r=0.59 [26]. Because normality checks showed that

the intake was not normally distributed, we dichotomized SSB consumption into more than 400 ml (1) vs. equal or less than 400 ml (0) per day, according to the median value of the data set. This value also represents an often recommended maximum intake of SSBs and provides therefore a meaningful cut-off point.

Individual cognitions and environmental factors

Cognitions specific for drinking less SSB according to the TPB (attitude, subjective norm, perceived behavioural control, and intention) were assessed on 5-point bipolar scales. General attitude toward drinking less SSB was measured with one item (e.g. For me drinking less SSB is very bad (-2) – very good (+2)). Parental subjective norm was assessed with one item (e.g. Do you think your parents want you to drink less SSB? Certainly yes (+2) -certainly not (-2)). Perceived behavioural control was assessed with two items covering the dimensions easy/difficult (e.g. Do you think it is difficult or easy to drink less SSB? Very difficult (-2) – very easy (+2)) and the likelihood of succeeding (e.g. Do you think you will succeed in drinking less SSB if you want to? Certainly yes (+2) – certainly not (-2)). These two variables were combined into one construct perceived behavioural control (Cronbach's alpha was 0.74). Intention to change the behaviour was assessed with one item (e.g. Do you intend to drink less SSB in the upcoming year? Certainly yes (+2) – certainly not (-2)). All individual cognitions were dichotomized because of the skewed distributions, where –2 till 0 were coded as 0 and +1 till +2 was coded as 1.

Perceived home availability and the family food rule were assessed using 5-point scales. Availability at home was assessed with one item (e.g. Are there SSB available at home? Always (+2), almost always (+1), sometimes (0), seldom (-1), never (-2)). This item was dichotomized as –2 till 0 as 0 and +1 till +2 as 1. The family food rule was assessed with one item (e.g. Are you allowed to drink as much SSB as you like at home? Always (-2), almost always (-1), sometimes (0), seldom (+1), never (+2)). This item was dichotomized as -2 till -1 as 0 (liberal) and 0 till +2 as 1 (strict).

Demographics

Questions on age (How old are you? 11 – 18 or older), gender (Are you a boy or a girl? Boy; girl), educational level (Indicate what level of education you attend (low vocational; higher vocation; middle; pre-university; pre-university plus) and ethnicity (assessed with 3 item: what is your country of birth? What is your

mother's country of birth? What is your father's country of birth) were included in the questionnaire. Respondents' ethnicity was categorized as either Dutch (both parents are born in the Netherlands) or non-Dutch according to Statistics Netherlands [27].

Analyses

Respondents with missing data on the potential determinants or intakes at baseline and/or at follow-up were deleted from the analyses (n=36). Z-scores (value minus the mean of all values divided by the standard deviation) for the intakes were calculated and outliers above z-score 3.29 ($p < .001$, two-tailed test) were recoded to missing (n=14). In addition, SSB intake levels above an average of 3 litres per day were truncated at 3 litres (n=20).

Multilevel logistic regression analyses were performed using MlwiN 2.02. A two-level structure was used to take the nesting structure of students within schools into account [28]. We fitted a model with the intercept and the baseline intake variable to examine the significance of the between school variance in changes in intake between schools. Significance was calculated with the one tailed Wald statistic following a Chi-Square distribution with one degree of freedom. Significance of variance would indicate that the SSB intake clusters within schools. However, the between-school variance (random intercept) was 0.000 and consequently multilevel analyses were not required. Thus, we continued the regression analyses in SPSS 15.0.

We fitted several regression models [29]. First, we fitted a model with potentially confounder variables gender, age and ethnicity and baseline intake. Second, we added attitude, subjective norm and perceived behavioural control to the model. This model shows the significance of the more distal TPB predictors on change in intake. Third, we added the most proximal TPB predictor intention to the model, to examine if intention was significantly related to change in intake after correcting for other predictors of the TPB and confounders. Fourth, we added availability and family food rule to the model, to investigate whether these factors were associated with change in intake after correcting for cognitive factors. Fifth, we removed the TPB variables from the model to be able to describe the association of the environmental factors and intake, only corrected for the baseline intake and background variables. The models with time 2 behaviour as dependent variable and time 1 behaviour as covariate allow for a prediction of change in behaviour over the 4 month period [30, 31]. So, an OR larger than one reflects an increased

likelihood of having changed to the higher intake group and thus a decreased likelihood that a high score on the determinant predicts a decrease in intake from >400ml to ≤400ml, while an OR lower than one reflects an increased likelihood that a high score on the determinant predicts a decrease in intake from >400ml to ≤400ml.

Mediation analysis following the product-of-coefficients test as described by McKinnon [32], was used to see if cognitive variables (at baseline) mediated the relation between the environmental factors (at baseline) and change in intake (intake at follow-up adjusted for baseline intake). Separate analyses were performed for the environmental factors availability and family food rules. An effect was said to be mediated if (1) the environmental variable had a statistically significant effect on the hypothesized mediator (cognitive variables; a coefficient); (2) the hypothesized mediator (the cognitive variable) was associated with the outcome (change in SSB consumption), after controlling for the environmental variable (b coefficient); (3) the mediated effect (product of the a and b coefficients) was statistically significant. Because the product of two coefficients is not normally distributed we used bootstrapping to determine the significance of the mediated effect [32]. With bootstrap the empirical distribution of the data is used to determine the confidence limits around the estimate of the mediated effect. A sample with replacement was drawn 1000 times from the original study sample. In each new sample the mediated effect, a*b, was estimated. The mediated effect estimated in each bootstrap sample was used to form a bootstrap distribution of the mediated effect estimates, and 95% confidence limits were obtained from the bootstrap distribution (the 2.5^{th} and 97.5^{th} percentiles) [32]. Percentage mediated effect was calculated as ab/c, where c is the coefficient in the relation between predictor (availability or family food rules) and outcome (change in SSB). All statistical models employed in these analyses were adjusted for a set of covariates, namely gender, educational level, ethnicity and baseline intake. Mediation analyses were performed with S-PLUS 6.0.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Medical Ethics Committee of the Erasmus University Medical Centre. Written informed consent was obtained from all students and parents.

RESULTS

Approximately 73% of the study participants were Dutch and 51% attended higher secondary schools (Table 1). Individual cognitions regarding decreasing intake of SSB, food rule and perceived availability of SSB are described in Table 2, showing that 23% indented to drink less SSB in the future. In approximately 76% of the homes of the students SSBs were always or almost always available.

Table 1 Demographic characteristic of the participating students (Netherlands; 12-13 year) at baseline (2006-2007)

	Students (n 348)		
	Percentage	Mean	SD
Sex (% boys)	47.7		
Ethnicity (% Dutch)	72.7		
School level (% high level*)	50.6		
Age baseline (years)		12.6	0.58

*High school level is pre-university and pre-university plus (Havo/VWO)

Table 2 Description of cognitive and environmental variables and intake levels for sugar-sweetened beverages consumption of study participants at baseline (n=348, 2006-2007; Netherlands, 12-13 year)

	Percentage of students
Individual cognitions	
Attitude to drink less	
Negative/neutral	53.7
Positive	46.3
Parental subjective norm to drink less	
Negative/neutral	78.7
Positive	21.3
Perceived behavioural control to drink less	
Negative/neutral	30.2
Positive	69.8
Intention to drink less	
Negative/neutral	77.0
Positive	23.0
Environment	
Availability at home	
Never/ seldom /sometimes	24.1
Almost always – always	75.9
Family food rule (allowed to drink as much SSB as liked)	
Non-restrictive (almost always/ always)	47.1
Neutral / restrictive (never/ seldom/ sometimes)	52.9
Behaviour	
SSB consumption	
Baseline: intake >400ml per day	45.1
Follow-up: intake >400ml per day	48.3

SSB, sugar-sweetened beverages

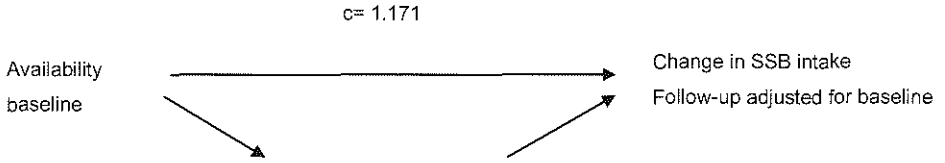
Table 3 Multilevel stepwise logistic regression of change in sugar-sweetened beverages consumption on hypothesized predictors (cognitions and environmental factors) (n=348; Netherlands; year 2006-2007; age 12-13)

	MODEL 1 (R^2=24%)**	MODEL 2 (R^2=28%)	MODEL 3 (R^2=28%)	MODEL 4 (R^2=33%)	MODEL 5 (R^2=31%)
Baseline intake: OR	5.52*	4.38*	4.22*	3.36*	4.03*
(95% CI)	(3.45 – 8.83)	(2.67 – 7.19)	(2.56 – 6.95)	(1.99 – 5.66)	(2.46 – 6.61)
Gender (girls vs. boys) : OR	0.57*	0.58*	0.58*	0.51*	0.49*
(95% CI)	(0.35 – 0.91)	(0.36 – 0.95)	(0.36 – 0.94)	(0.31 – 0.85)	(0.30 – 0.81)
Education (high vs. low) : OR	0.82	0.80	0.77	0.80	0.83
(95% CI)	(0.51 – 1.31)	(0.49 – 1.29)	(0.48 – 1.26)	(0.49 – 1.33)	(0.51 – 1.35)
Ethnicity (non-Dutch vs. Dutch) : OR	0.90	0.79	0.79	0.82	0.93
(95% CI)	(0.53 – 1.52)	(0.44 – 1.40)	(0.44 – 1.41)	(0.45 – 1.51)	(0.54 – 1.62)
Attitude (high vs. low) : OR		0.60*	0.64	0.65	
(95% CI)		(0.36 – 0.98)	(0.38 – 1.07)	(0.38 – 1.12)	
Subjective norm (high vs. low) : OR		0.78	0.82	0.88	
(95% CI)		(0.41 – 1.49)	(0.42 – 1.59)	(0.44 – 1.74)	
PBC (high vs. low) : OR		0.44*	0.45*	0.53*	
(95% CI)		(0.25 – 0.76)	(0.25 – 0.80)	(0.30 – 0.97)	
Intention (high vs. low) : OR			0.73	0.86	
(95% CI)			(0.40 – 1.35)	(0.45 – 1.62)	
Availability (high vs. low) : OR				2.39*	2.59*
(95% CI)				(1.27 – 4.51)	(1.40 – 4.77)
Family food rules (restrictive vs. non-restrictive) : OR				0.54*	0.49*
(95% CI)				(0.32 – 0.91)	(0.29 – 0.81)

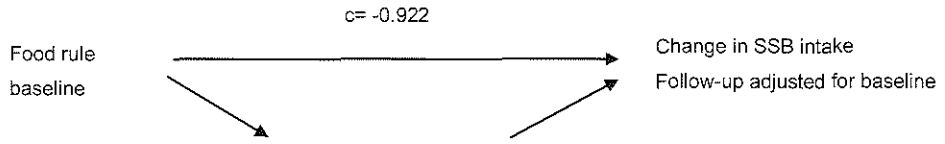
R^2, percentage variance explained; OR, odds ratio; CI, confidence interval; PBC, perceived behavioural control; * significant predictors; ** Baseline intake and gender together explain 23% of the variance.

About half of the students (47%) were allowed to drink as much as they wanted to. Almost half of the adolescents drank 400ml or more per day. Approximately 18% of the students decreased their intake from >400 to ≤400 ml per day and 14% of the students increased their intake.

Table 3 shows the results of the stepwise logistic regression analysis on change in intake categories of SSB (more than 400 ml or equal or less than 400 ml). Being a girl was associated with a lower likelihood for an increase in consumption. Additionally, a positive perceived behavioural control and a positive attitude to decrease sugar-sweetened beverages consumption were related to a decrease in consumption over time (model 2). This relationship became non-significant for attitude, but remained significant for perceived behavioural control when intention, food rule and perceived availability were added to the model (model 3 and 4). In model 4, lower home availability and more restrictions on consumption were associated with a decrease in consumption over time. No significant relations



a	Cognition at baseline	b	ab (95% CI)
0.009	Attitude	-0.591	-0.005 (-0.385; 0.350)
0.308	Subjective norm	-0.243	-0.075 (-0.552; 0.270)
-1.317	Perceived behavioural control	-0.607	**0.800** (0.047; 1.941)
-0.432	Intention	-0.443	0.191 (-0.161; 0.669)



a	Cognition at baseline	b	ab (95% CI)
0.711	Attitude	-0.440	-0.313 (-0.816; 0.052)
0.897	Subjective norm	0.009	0.008 (-0.654; 0.612)
0.265	Perceived behavioural control	-0.768	-0.204 (-0.783; 0.166)
0.967	Intention	-0.354	-0.342 (-1.120; 0.226)

Figure 2 Mediation analyses of cognitions to drink less sugar-sweetened beverages (SSB) in the association between availability (top of the figure)/food rule (bottom of the figure) and intake (n=348; Netherlands; year 2006-2007; age 12-13); a,b and c are beta coefficients; CI, confidence interval

with change in SSB consumption were found for education, ethnicity, subjective norm and intention. Perceived availability and food rule were directly associated with SSB consumption after controlling for baseline and background variables (model 5).

The relationship between availability and change in sugar-sweetened beverages consumption was mediated by perceived behavioural control to decrease intake (top of Figure 2). Of the association between availability and change in SSB intake, 68% was mediated by perceived behavioural control. So, low availability is associated with high perceived behavioural control to decrease intake and this is associated with a decrease in intake. The relationship between availability or food rule and change in SSB consumption was not significantly mediated by any other cognition (bottom of Figure 2).

DISCUSSION

Main findings

This study is one of the few studies that examined potential cognitive determinants of decreasing SSB intake as well as family food rules and perceived home availability of SSB as predictors of change in SSB consumption using longitudinal data. Our results show that adolescents with a high perceived behavioural control and more positive attitudes to decrease SSB intake were more likely to decrease their intake. In addition, adolescents reporting low availability of SSB at home and a family food rule that restricted them to drink as much sugar sweetened beverages as they liked, were more likely to decrease their intake as compared to students with high availability and a less strict rule. The association between availability and decrease in SSB consumption was almost completely mediated by perceived behavioural control, which means that most of the effect of low availability on decrease in intake is explained by perceived behavioural control, i.e., children feel confident in reducing their SSB consumption when availability of SSB is limited.

Explanation and interpretation of results

Literature on cognitive determinants of SSB consumption shows that attitudes, subjective norm and intentions of consuming SSB are related to intake [4, 5, 12, 13, 15, 19]. The relationship between perceived behavioural control and SSB consumption is unclear [4, 5, 12, 13, 16, 19]. We found significant relationships for attitudes and perceived behavioural control with changes in intake, but not for subjective norm and intention. Differences in results among different studies might be explained by different types of determinants that were measured as well as differences in study designs and the ways the potential determinants were assessed. We assessed determinants of behaviour change, while other studies measured determinants of low intake or situational intake. In addition, the design of this study was longitudinal, whereas the designs of most other studies (except [4]) were cross-sectional. This difference may reveal differential associations, because longitudinal outcomes represent prediction and possibly causality, while cross-sectional studies only provide information on association. We were not able to test differences in associations between cross-sectional and longitudinal associations within the present study because of the way we assessed the cognitive factors (i.e. as related to change in behaviour).

Regarding possible physical and political environmental determinants, our results showed that higher availability at home and a less strict family food rule were

related to an increase in SSB intake. No other studies on possible determinants of change in intake have been published, but we could compare our results with studies on possible determinants of intake. In that case, our results are in accordance with most previous research [4, 12, 13, 16]. However, one study showed that availability was not related in girls and family food rules were not related with intake in boys and girls [16]. Furthermore, higher availability at home has been shown to be positively related to higher perceived behavioural control to drink soda [12, 13]. In accordance, we found that higher home availability is related to a lower perceived behavioural control to drink less SSB. In addition, we found that perceived behavioural control mediates the relationship between availability and intake. The relationship between availability and perceived behavioural control indicates that one could influence an adolescents' perceived behavioural control by altering the home availability, which might add greatly to a direct target of increasing the perceived behavioural control of an adolescent. We did not find any mediation of cognitions in the relationship between family food rules and SSB intake. This confirms previous research where more strict parental practices were related to less SSB consumption, but this effect was largely unmediated by social cognitions [4]. The direct association between high perceived behavioural control, high home availability and a strict parental rule, and intake indicate that in future interventions to decrease SSB consumption these cognitive and environmental factors should be targeted. The mediation between availability and intake by perceived behavioural control emphasizes the important role of home availability and stresses the importance of targeting home availability in future interventions. So, our results suggest an important role for parents. Although adolescents are becoming more autonomous while growing up, the influence of the parents is still important.

Limitations

The first limitation of this study regards the follow-up period that we used with regard to the stability of the possible determinants. The time lag between baseline and follow-up may have been too long, thus obscuring relevant relationships in shorter periods of time. The optimal follow-up period is related to stability of determinants within students over time. We could not find any research regarding the stability of determinants of behaviour change. Individual cognitions of behaviours are considered stable over a longer time period [33]. However, determinants of behaviour change might be more susceptible to variations due to e.g. healthy eating campaigns, obscuring the relations that we examined.

The second limitation is that both behaviour and determinants are self-reported, which might lead to recall bias and social desirable answers. Overweight girls tend to underreport mainly foods high in energy-density and low in nutrients, like SSB [34]. However, this does not necessarily mean that change in intake over a four month period is prone to bias as well.

The third limitation is that we dichotomized the outcome variable, SSB intake, because of its skewed distribution. The dichotomized outcome is probably a less sensitive outcome measure than a continuous one, because you look at change between intake categories (more or equal/less than 400 ml) and not at any change in intake, resulting in an underestimation of the change in intake. Only when changes in intake were present around the 400 ml turning point the dichotomized outcome would be more sensitive. Examination of our data shows that this latter situation is not applicable in our study. Despite the weaker dichotomized outcome measure we did find significant relations, indicating that these predictors are strong predictors of change in intake.

A fourth limitation is that we assessed the cognitive factors with one (attitude, subjective norm, intention) or two-item (perceived behavioural control) measures. These measures may have only covered part of the larger construct. For example, one's attitude towards SSB intake may not only include an evaluation in terms of good and bad, but also pleasant/unpleasant. However, it is likely that the subtle differences between different evaluations of the same construct are not acknowledged by adolescents. The age group and the class-room administration of the questionnaire forced us to restrict the number of questions as much as possible.

A fifth limitation is that we cannot rule out any seasonal influences on SSB intake, leading to differences in intakes between the measurements. However, because we did not include the summer period in our study, large seasonal variations are not likely.

Conclusions

The present longitudinal study provides important new insights in cognitive and environmental predictors of changes in SSB consumption. Both personal cognitions (attitude and perceived behavioural control) and factors in the home environment (availability and parental rules) appear to be important for adolescents' changes in SSB consumption. The results suggest that interventions to decrease SSB intake should focus on improving attitudes and perceived behavioural control

to reduce intake, and on limiting home availability and stimulating stricter family food rules regarding SSB consumption.

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The authors declare no conflict of interests. NE, AE, AO and JB contributed to the design of the study; NE, AE, MS, AO and JB contributed to the analyses and to the drafting of the manuscript.

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Part 3

Development and evaluation of FATaintPHAT

Chapter 5

Design and evaluation protocol of "FATaintPHAT", a computer-tailored intervention to prevent excessive weight gain in adolescents

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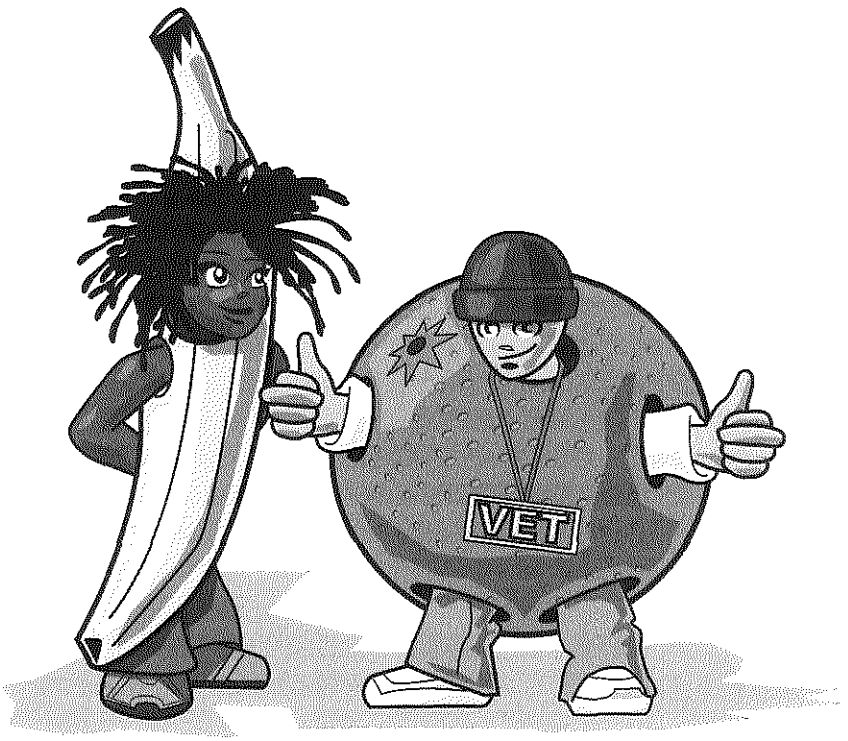
BMC Public Health 2007, 7: 324



ABSTRACT

Background: Computer tailoring may be a promising technique for prevention of overweight in adolescents. However, very few well-developed, evidence-based computer-tailored interventions are available for this target group. We developed and evaluated a school-based computer-tailored intervention for adolescents targeting energy balance-related behaviours: i.e. consumption of snacks, sugar-sweetened beverages, fruit, vegetables, and fibre, physical activity, and sedentary behaviours. This paper describes the planned development of and the protocol for evaluating this intervention.

Design: Intervention development: Informed by the Precaution Adoption Process Model and the Theory of Planned Behaviour, the computer-tailored intervention provided feedback on personal behaviour and suggestions on how to modify it. The intervention (VETisnietVET translated as 'FATaintPHAT') has been developed for use in the first year of secondary school during eight lessons.

Evaluation design: The intervention will be evaluated in a cluster-randomised trial including 20 schools with a 4-months and a 2-years follow-up. Outcome measures are BMI, waist circumference, energy balance-related behaviours, and potential determinants of these behaviours. Process measures are appreciation of and satisfaction with the program, exposure to the program's content, and implementation facilitators and barriers measured among students and teachers.

Discussion: This project resulted in a theory and evidence-based intervention that can be implemented in a school setting. A large-scale cluster randomised controlled trial with a short and long-term follow-up will provide sound statements about the effectiveness of this computer-tailored intervention in adolescents.

INTRODUCTION

Increasing numbers of adolescents worldwide are overweight and obese [1]. In the Netherlands 22% of girls and 18% of boys are considered overweight or obese [2]. Obesity is associated with an increased risk of chronic diseases (e.g. cardiovascular disease, type 2 diabetes, and cancer), and some of these may already become manifest at an early age. Overweight and obese adolescents are likely to become overweight or obese adults [1, 3, 4]. Furthermore, treatment of overweight and obesity is generally disappointing [1, 5]. Therefore, prevention of overweight and obesity is an important strategy in fighting the obesity epidemic. To prevent adolescents from becoming overweight or obese, there is an urgent need for interventions aimed at preventing excessive weight gain in adolescents.

Overweight is the result of a long-term imbalance between energy intake (through the diet) and energy expenditure (mainly through physical activity). Interventions aimed at prevention of excessive weight gain should preferably target both sides of the energy balance. Various specific behaviours regarding diet and physical activity have been suggested to be related to the energy balance: i.e. the consumption of snacks, sugar-sweetened beverages, fruit, vegetables, and fibre, as well as physical activity, television viewing and computer use [6-10]. These behaviours should therefore be targeted in interventions.

Computer tailoring is a promising health communication technique to alter dietary and physical activity behaviours in adults [11]. The technique may also be suitable for modifying energy balance-related behaviours (EBRBs) in adolescents [12]. Computer tailoring is intended to reach one specific person by addressing characteristics that are unique to that person, related to a specific behaviour, and derived from an individual assessment [13]. The theoretical rationale behind computer tailoring is that non-personally relevant information is eliminated as much as possible. Therefore, people will pay more attention to the information, appreciate the information more, and find it more interesting. Theories of information processing (such as the Elaboration Likelihood Model), show that information that is attended to and thoughtfully considered is more likely to influence the person's awareness, knowledge, attitudes, beliefs, and behaviours [13]. Thus, computer tailoring might be a useful strategy to use for prevention of excessive weight gain in adolescents. However, very few studies have explored the effectiveness of computer-tailored interventions in adolescents.

Intervention development should follow a planned approach using theories and existing evidence [14, 15]. The outcomes of this planned approach should be made available for researchers to support a profound interpretation of the study results, and to enhance the development of future interventions [11, 14]. We developed a web-based computer-tailored intervention (CTI) named VETisnietVET (the closest English translation would be FATaintPHAT), which was used during first-year lessons at secondary schools and aimed at prevention of excessive weight gain. The school setting provides a natural learning environment for adolescents and ensures that all adolescents are exposed to the intervention. A planned, theory and evidence-based approach to intervention development was taken, and the intervention will be evaluated on the short and longer term. This paper describes the steps in the planned development of the intervention and the study design for evaluating the effectiveness of the intervention.

METHODS

The intervention

Intervention objectives and behavioural goals

The objective of the intervention was to prevent excessive weight gain among adolescents aged 12 to 13 years. The increasing autonomy during adolescence might provide a window of opportunity to acquire healthy diet and physical activity patterns. Adolescents from diverse ethnic backgrounds (about half of the adolescents in the research area are from non-Dutch origin), school levels (from vocational to pre-university education) and socio-economic positions (from areas with various socio-economic characteristics) were the focus of the intervention. To achieve the intervention objective, the CTI aimed at improving the following EBRBs: consumption of sugar-sweetened beverages, snacks, fruit, vegetables, and fibre, as well as television/computer use, and physical activity [16-19]. For each behaviour cut-off points were set based on literature research, the recommendations of the National Nutrition Centre, and on the Dutch norms for physical activity [20] (Table 1).

Theoretical background and determinants addressed

The theoretical model used as the basis of the intervention was a combination of the Precaution Adoption Process Model (PAPM) and the Theory of Planned

Table 1 Recommendations and cut-off points used to provide feedback on the student's behaviour

Behaviour	Cut-off points applied
Consumption of sugar-sweetened beverages and fruit juice	Maximum of two glasses per day (approximately 400 ml)
Snack consumption	Maximum of three in-between-meal moments of eating, where the calories from relatively unhealthy snacks should not exceed the number of calories from relatively healthy snacks.
Fruit consumption	Minimum of two portions of fruit per day
Vegetable consumption	Minimum of 200 grams of vegetables per day (4 tablespoons)
Fibre consumption	Whole wheat bread (instead of white bread), breakfast with bread or cereal, rice/pasta/potato with dinner, four tablespoons of vegetables, and two pieces of fruit per day
Physical activity	At least one hour of moderate to vigorous intensity physical activity per day
Television and computer use	No more than two hours of television viewing and computer use combined per day

Behaviour (TPB). These theories define important and changeable determinants to be addressed in the intervention. According to the PAPM, awareness of one's risk behaviour is an important determinant for the intention to change [21]. Lack of awareness is a determinant that is often an issue in complex health-related behaviour, such as dietary intake and physical activity [22, 23]. Important determinants from the TPB that were targeted in the intervention are attitude, subjective norm, perceived behavioural control, and intention to change. In addition, other psychosocial constructs identified as being relevant in earlier studies were addressed, namely social support, skills, and planning.

General intervention framework

We implemented the Internet-delivered intervention in the school setting to reach all students (from different socio-economic and ethnic groups) and to present the intervention in a natural learning environment. The intervention website consisted of eight modules that could be used and completed in separate sessions. The homepage introduced the purpose and the importance of the FATaintPHAT program, and how the program could be used. The first module introduced the concept of weight, weight gain and related behaviours, and included an assessment of and feedback on an individual's BMI (Body Mass Index). Each of the other seven modules addressed one of the seven relevant behaviours. Every module consisted of an assessment questionnaire, individually-tailored feedback and advice, and an element to formulate an implementation intention. The feedback was presented on the computer screen immediately after the questionnaire had been completed and could be printed. Each subsequent module could be accessed after the previous one had been completed. The students could work through one session per

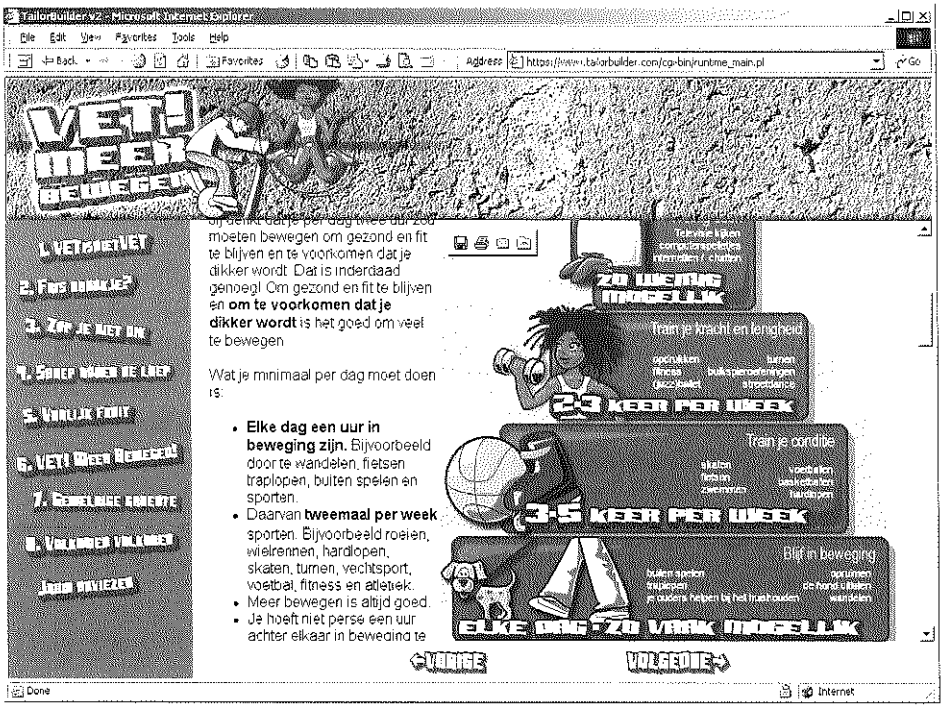


Figure 1 Screenshot of the FATaintPHAT intervention

lesson, and the whole program could be worked through in eight lessons. For each module the resulting feedback, advice, and formulated implementation intention could be read again in the module "Your advice".

To increase the likelihood that the intervention would be adopted, we involved students and teachers in various parts of the development process. With 10 adolescents we discussed various possible titles for the intervention website; they preferred the name FATaintPHAT and understood the meaning. We also asked their opinions about different lay-outs for the website (designed especially for adolescents by a design bureau) to assess acceptability of the lay-outs, and whether there was a difference between boys and girls in level of acceptability. The lay-out as shown in Figure 1 emerged as the favourite, although it was appreciated more by the boys than by the girls. After extensive testing for accuracy by the researchers, nine experts in the field of nutrition, physical activity, and health education tested the website and commented on its content. Based on their feedback we modified the questions and feedback messages.

To prevent the intervention from inducing worrisome dieting behaviours in adolescents with a low BMI [24], underweight girls and boys received neutral information about healthy eating and physical activity, and were not advised to reduce their energy intake or to increase their physical activity level based on their diet and physical activity patterns. Being underweight was identified based on the BMI test that was part of the intervention and was defined as having a BMI below the cut-off points in the Dutch population as described previously [25].

Content of the computer tailoring program

The tailoring program consisted of assessment instruments, feedback libraries, tailoring algorithms to link up the outcomes of the assessment with the relevant messages in the feedback library, and a webpage to present the complete tailored communication [13, 26]. To build the program we used the Tailorbuilder software (OSE, Sittard, The Netherlands [27]), which was specifically developed for production of Internet-delivered computer-tailored programs.

A screening instrument for each separate behaviour was developed that assessed the behaviour, perception of the behaviour, and the determinants related to that behaviour. Where possible we used parts of existing computer-tailored interventions. After completion of the questionnaire, feedback on a knowledge test and on personal behaviour in relation to the behaviour-specific recommendation was provided. Subsequently, feedback was provided on intention, attitudes, subjective norm, and perceived behavioural control. Students in the early stages of the PAPM received feedback to promote changes in attitudes, whereas for students in the later stages of the PAPM the focus was on perceived behavioural control. For improving perceived behavioural control, feedback on social support, skills, and planning was provided.

To promote changes in these behavioural determinants, a choice can be made from a variety of methods. A method is defined as a general technique or process to influence changes in the determinants of behaviours (and environmental conditions) [28]. An overview of the methods that were used is given in Table 2, as well as examples of feedback messages in which this method was applied.

Pre-test of the intervention

A pre-final version of the intervention was pre-tested for usability, comprehension and acceptability among a small group of adolescents aged 12-14 years. Par-

Table 2 Overview and examples of the methods used in the feedback messages of the FATaintPHAT intervention

Determinant	Methods	Example from FATaintPHAT
Knowledge	• Provide factual information • Multiple-choice knowledge test	"Do you know how many sugar cubes there are in a single glass of Coke? There are 8 of them! You have to jog for 15 minutes to burn up this sugar!"
Awareness of risk behaviour	• Personal feedback • Normative feedback • Comparison with peers	"Your answers show that you are watching television/ using the computer for three hours a day. You think that this is not that much, but it is really too much!"
Intention to change	• Re-evaluation of intention to change behaviour	"Intending to exercise more? You say you haven't really thought about it. But maybe you've changed your mind, knowing that you exercise too little."
Attitude towards behaviour change	• Reinforce existing beliefs • Re-evaluation of beliefs • Present new arguments • Present counterarguments • Dismantle prejudices	"Exercising is sweating. And you don't like that. Exercising makes you warm and to loose your warmth you need to sweat. That's very normal. Sweating means you are doing something good and nice! And is sweating really so bad... when you can take a nice shower afterwards?"
Perceived behavioural control	• Provide practical tips and tricks • Discussion of difficult situations • Organizing environmental and social support	"Choose to eat your fruit at fixed moments of the day, you won't forget it then, e.g.: – In between meals: you can eat fruit instead of candy or cake. – Breakfast: you can put fruit on your bread and with your yoghurt or milk. Think of bananas or strawberries."
Planning	• Formulate implementation intention	"Example: *What?* Eat a piece of fruit instead of a candy bar *Where?* At school *When?* During the short break in the morning. Now make your own plan!"

ticipants for the pre-test were recruited from two classes of two different schools (vocational and pre-university). Quantitative research was carried out among the vocational school students using questionnaires addressing the usability, appreciation, comprehension, and time needed to complete each module. Qualitative research was carried out using 'think aloud' sessions with 15 students of the pre-university class, to get detailed information about the usability and comprehension of the intervention. The results of the qualitative and quantitative pre-test showed that the usability, acceptability and comprehensibility were acceptable. Minor adaptations were made to improve text comprehension (e.g. the difference between soft drinks and fruit juice), usability (e.g. a missing 'next' button), and tailoring algorithms. In addition, the pre-test demonstrated the time that students needed to complete each module.

Evaluation design

Objectives and design

The effectiveness of the intervention will be evaluated in a two-group (intervention and control) cluster-randomised trial with a 4-months and 2-years follow-up, among adolescents aged 12 - 13 years at the start of the study (Figure 2). The outcome measures are BMI and waist circumference (at 2-years follow-up), and the EBRBs and their determinants (at 4-months and at 2-years follow-up). Hypotheses to be tested are:

- The intervention group has a lower BMI and waist circumference, compared to the control group at 2-years follow-up.
- The intervention group has more favourable outcomes on the targeted behaviours, compared to the control group at 4-months and 2-years follow-up.
- The intervention group is more aware of their risk behaviours and has more positive attitudes, perceived behavioural control and intentions toward

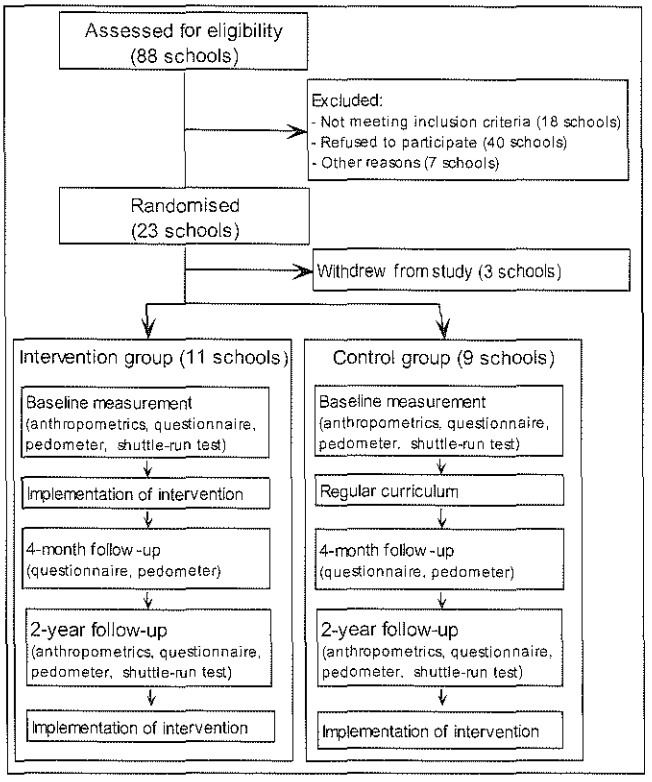


Figure 2 Flow chart of the recruitment and randomisation of schools

changing their risk behaviours, compared to the control group at 4-months and 2-years follow-up.
- Availability and accessibility of foods and physical activity opportunities in the home and school environment moderate the intervention effects.

In addition to testing the main hypotheses, secondary analyses will be performed to answer other relevant research questions.

The evaluation of effects will be accompanied by a process evaluation. Process level outcome measures are appreciation of and satisfaction with the intervention content, implementation rates (how well the intervention is implemented in school lessons) and exposure to the intervention content, and opinions of teachers about barriers and facilitators for intervention implementation.

The study was approved by the Medical Ethics Committee of the Erasmus MC.

Recruitment of schools and students

Recruitment of schools and classes

Recruitment of schools and logistics of the study was organized in collaboration with the municipal health organisations, who also sent the first invitational letter or email to the 88 schools in Rotterdam and surrounding municipalities in the Netherlands. The letter or email explained the purpose, design and logistics of the study and asked school directors to consider participation. Thereupon, a researcher telephoned all schools to provide additional information and asked for willingness to participate. If schools were interested to participate, eligibility was assessed by checking that the school did not meet the criteria for exclusion. The exclusion criteria concerned offering special sports education, having students who are not able to fill in a questionnaire, and having scheduled other interventions for weight control. Four classes of each school were randomly selected to participate, although in five schools the school representative selected participating classes non-randomly, because of time schedules and computer room availability.

To have sufficient power to detect a relevant difference of 1.0 kg (standard deviation 5 kg) in mean bodyweight between intervention and control group with power 0.80 and alpha 0.05, a minimum of 20 participating schools and four classes within each school was needed. This takes into account the cluster-randomised design, unreturned informed consent forms, refusal to participate, and expected drop-out during follow-up. Twenty-three schools were willing to participate in the study (Figure 2).

Randomisation procedure

Schools were randomly assigned to either the intervention or control group, using block randomisation. Block randomisation allows to start with the study while still including schools. Schools were stratified according to educational level, with vocational education in one stratum and higher than vocational education in the other stratum. Eleven schools were randomised in the intervention group (7 vocational; 4 higher than vocational) and twelve in the control group (7 vocational; 5 higher than vocational). Three schools withdrew from the study before the baseline measurement (2 vocational, 1 higher than vocational; all from the control group). Reason for withdrawal was experiencing the informed consent procedure as troublesome, and return of consent forms close to zero percent.

Recruitment of adolescents

During the school year, one school after the other started with the research activities. Per school, all the students in the selected classes were invited to participate. A researcher or teacher briefly explained the purpose and procedure of the study in the classroom. In addition, information letters providing details about the study and informed consent forms for the students and the parents were handed out. The adolescents were asked to give the information letter and the consent form to their parents and return the completed forms to the teacher. A total of 1156 (77%) of a total of 1494 students returned their forms and 883 students (59%) agreed to participate in the study. Only adolescents for whom full consent (their own and their parents) was obtained were enrolled in the study.

Procedure

Procedure of the effectiveness study

To assess the outcome measures for the effectiveness study, a variety of measurements/instruments were used: questionnaires, body measurements, shuttle-run tests, and pedometers. To discuss in which lessons these measurements would be conducted, appointments were made with school representatives. The computer questionnaires were completed under supervision of a researcher during a class hour. The researcher explained the procedure for the completion of the questionnaire at the beginning of the lesson and was available to answer questions. Non-participating students were instructed by the teacher to do something else. Pedometers and diary forms were handed out to five randomly chosen students of each class, who would wear them for one week (after completion of the questionnaire). After one week a researcher would collect the pedometers and forms. Weight, height, and waist circumference were measured at school one week after

completion of the questionnaire by trained researchers and assistants. Students were individually measured to ensure privacy. Fitness was measured with a shuttle-run test performed by the physical activity teacher according to our protocol. Length of the circuit was measured to correct for gyms that are shorter than 20 meters. The measurement scheme is shown in Figure 2. Height and weight, waist circumference, and aerobic fitness were measured at baseline and 2-year follow-up. The behaviours and behavioural determinants were measured at baseline and at both follow-up points.

Procedure of the process evaluation

A process evaluation among students and teachers will provide information on the appreciation of the intervention, on the quality of the implementation of the intervention in schools, and usability in teaching practice. The students' process evaluation questionnaire was administered as part of the final module of the intervention. The teachers were asked to complete a logbook, which was part of the teacher manual. In addition, a telephone interview was held with each teacher who worked with the intervention.

Intervention implementation

The intervention was implemented by the teachers. Teachers received a teacher manual including instructions on the implementation schedule, on the content and procedure of working with the website itself, and on trouble-shooting. In addition, all teachers were phoned at the start of the intervention period to see if any problems that might hinder the implementation could occur. Practical problems were then solved. The implementation instructions were to work through the 8 modules in 8 lessons in sessions of about 15 minutes. In the last session the students had to go to 'Your advice' and read the most important advice again. Within a 10-week intervention period the teachers had to implement this 8-weeks program, preferably one session each week in 8 subsequent weeks, but with a 2-week margin. The teachers received passwords for all students to enter the program. In two of the intervention schools the researchers assisted with the implementation of the program because these schools had a lack of school staff during the implementation period.

Measurements

Body measurements

The BMI, calculated as weight (in kilograms) divided by height squared (in meters), and waist circumference were measured by trained research assistants,

following a protocol. Body height was measured twice without shoes using a Seca 225 mobile height rod with an accuracy of 0.1 cm. A calibrated electronic digital floor scale (SECA 888 class III) was used to measure, with an accuracy of 0.2 kilogram, the body weight of the students, who were wearing sports clothes or their underwear and a T-shirt. Waist circumference was measured twice using flexible bands of Seca, with an accuracy of 0.1 cm. In case of a difference of more than 1.0 cm between these two measurements, the waist circumference was measured twice again.

Questionnaires

Electronic, self-administered questionnaires were used to assess self-reported behaviour, behavioural determinants, and potential behavioural determinants regarding prevention of getting fat. Completion of the questionnaire took about 30 to 60 minutes.

Behaviour

Physical activity and sedentary behaviour were assessed using an adapted version of the Flemish validated questionnaire [29]. This questionnaire assesses physical activity at school and during leisure time (e.g. sports), active transportation to school, television viewing, and computer use during leisure time in the past seven days by asking about the frequency and duration of the activities. The questionnaire contains 31 questions. Test-retest reliability coefficients for the physical activity sub-behaviours vary between 0.68 and 1.00.

Dietary intake was assessed using a food frequency questionnaire assessing the frequency and quantity of a variety of foods (snacks, soft drinks, fruit and vegetable, fibre-rich products) eaten in the past week and a self-administered 24-hour recall of the specific food items. Adapted versions of validated questionnaires were used for snacks intake [30] and for fruit and vegetables intake [31]. The dietary questionnaire contains 39 questions.

Determinants of the behaviours

Attitude, subjective norm, perceived behavioural control, and intention were assessed with respect to changing the desired behaviour (e.g. increase physical activity). All the questions on the TPB variables, and availability and accessibility, were measured on a 5-point bipolar scale. Attitude was measured with two items regarding the beliefs good/bad, and helpful/not helpful to prevent getting fat (e.g. For me drinking less sugar-sweetened beverages is very bad - very good) and subjective norm with one (e.g. Do you think your parents want you to eat

more vegetables? Certainly yes-certainly not). Perceived behavioural control was measured with two items covering the dimensions easy/difficult (e.g. Do you think it is very difficult or very easy to eat more vegetables?), and the likelihood of succeeding (e.g. Do you think you will succeed in eating more fruit if you want to? Certainly yes-certainly not). Intention to change the behaviour was assessed with one item (e.g. Do you intend to exercise more in the upcoming year? Certainly yes-certainly not). Self-rated intake was assessed with one item (e.g. Do you think you drink a lot or very few sugar-sweetened beverages?). In addition, availability and accessibility of food and opportunity to exercise at home and at school were assessed with two items (e.g. Are there sugar-sweetened beverages available at home? and Are you allowed to drink as many sugar-sweetened beverages as you like at home? Always-never). These items were assessed as potential moderators of intervention effects. Conscientiousness, one of the 'big five' personality traits, was measured using the short Dutch version of Big Five personality trait [32], with test-retest reliability coefficients of about 0.7. In total there were 60 behavioural determinant questions.

Prevention of getting fat

Questions about the concept of getting fat were included. Questions were measured on a five-point bipolar scale. Perception of a student's weight was measured with two items: Do you consider yourself as being too lean – too fat? and Do you consider yourself as being leaner – fatter than others of your age and gender? Attitude was assessed with two items: Do you consider preventing getting fat as good – bad? and Do you consider preventing getting fat as important – unimportant? Subjective norm was assessed by one item: Do you think your parents want you to prevent getting fat? Certainly yes-certainly not. Perceived behavioural control was assessed with two items: Do you think it is very difficult or very easy to prevent getting fat? and Do you think you will succeed in preventing getting fat? Certainly yes-certainly not. Intention was measured with one item: Do you intend to prevent getting fat in the coming two years? Certainly yes-certainly not. Perception of the risk of getting fat was measured with two items: Do you think you have a very high – very low chance of getting fat in the coming two years? and Do you think you have a much larger – much lower chance of getting fat in the upcoming two years compared to others of your age and gender? Stage of change related to prevention of weight gain was assessed using a staging algorithm based on the PAPM: what statement fits you best? I've never thought of preventing getting fat – I already take action to prevent getting fat. In addition, we asked whether the students felt in control over the prevention of getting fat with two items: Do you think you can do something yourself not to get fat? Certainly yes-certainly not,

and State five things you can do to prevent getting fat. In addition, we assessed overweight/obesity in the students' social environment: Is someone in your family too fat? No, yes one, yes more than one; Do you have friends who are too fat? No, yes one, yes more than one. In total there were 15 questions about the prevention of getting fat.

Demographics

Demographic questions included gender, age, educational level, country of birth, parents' country of birth, and postal code.

Pedometers

Physical activity level was measured with pedometers (Digiwalker SW200, New-Lifelstyles) in a random sub-sample of five students per class. Pedometers have shown to be a valid and reliable tool for assessment of physical activity [33, 34]. Students wore the pedometers for seven consecutive days on their belt or waistband on one side of the body. A diary was used to register the daily step count and periods/activities performed without wearing the pedometer.

Shuttle-run test

Aerobic fitness was measured with a shuttle-run test administered during physical exercise lessons. The shuttle-run test is a validated test which measures aerobic capacity by running back and forth for 20 meters, with an initial running pace of 8.0 km/h and a progressive 0.5 km/min increase of the running speed indicated by a sound [35]. The maximal performance is reached when the student does not cross the 20-m line at the moment of the beep for two consecutive 20-m distances. The number of minutes ran were counted with a precision of 0.5 minutes. Because not all school gyms are 20 meter in length, the area where the shuttle-run test takes place was measured to correct for differences between schools. The outcome was registered by the teacher and copied by the researchers.

Process measures

The students' questionnaire consisted of 24 questions using a 5-point bipolar scale. Topics covered for each module were: appreciation, personal relevance, and usefulness of the information. General questions were asked about: reading the information, printing the advice, reading the printouts afterwards, discussing the advice with parents and peers, using the advice in practice, considering the topic weight gain more often after finishing the program, the length of the modules, comprehensiveness of the information, finding the information interesting, learning new things, appearance, usability, and importance of the subject of

weight gain prevention. In addition, we asked students to rate the program from 1 to 10 and to state the two most and the two least interesting topics.

A detailed description of the implementation of the intervention in each class was constructed from the logbook, teachers' interviews, and server information (how the modules were used, whether all the modules were used, what was the time needed to implement each module). In addition, the teachers' interviews were used to explore the following topics: opinions about the barriers and facilitators for implementation (implementation in school setting and daily practice, responses of the students), teacher manual (is it used, is it clear), the teachers' opinion about the topic and the content of the CTI, and the participation of students in the study (to have qualitative views on the participation rates).

Statistical analysis

Multilevel regression analysis will be used to test for post-test group differences on the primary outcome measures. This technique adjusts for the dependency between observations of students from the same school [36].

DISCUSSION

In this paper we outlined the steps in the planned development of the FATaint-PHAT intervention and the protocol for the effectiveness and process evaluation. This study is one of the first CTIs to address seven EBRBs, and one of the first to evaluate a stand-alone CTI for adolescents. The intervention is an extensive CTI that targets the important EBRBs at both sides of the energy balance, i.e. eating and physical activity, in adolescents. Targeting seven important behaviours is not often applied in intervention research, but might be important because of the complicated functioning of the EBRBs together and because of limited positive effects reported in studies where only a few behaviours were targeted [16]. Many studies have shown that computer tailoring is a promising technique for changing health behaviours [11]. However, we do not know if this technique is useful for the prevention of excessive weight gain in adolescents. Our study enables to study the effectiveness of computer tailoring among adolescents.

The strengths of this study design are the size of the study (20 schools), the random controlled design, the short-term (4 months) and long-term (2 years) follow-up, and the inclusion of objective measures of BMI and physical activity. Limitations

of the study are that not all outcome measures have validated instruments available, and that some outcome measures are based on self-reports. In addition, because of including multiple-risk behaviours in the present study, we had limited space in the questionnaire to assess behavioural determinants in detail.

The results of the study will contribute to the body of evidence on computer tailoring and particularly to the effectiveness on weight gain, EBRBs, and the application among adolescents. In addition, if the intervention proves to be effective we will have a useful application that can readily be implemented in secondary schools, where there is a need for educational programs on weight maintenance.

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Chapter 6

Evaluation of the web-based computer-tailored FATaintPHAT intervention to promote energy balance among adolescents: Results from a school cluster randomised trial

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ABSTRACT

Objective: To evaluate the short- and long term results of FATaintPHAT, a web-based computer-tailored intervention aiming to increase physical activity, decrease sedentary behaviour and promote healthy eating to contribute to the prevention of excessive weight gain among adolescents.
Design: cluster randomised trial with an intervention and a no intervention control group
Setting: 20 schools, Rotterdam, the Netherlands
Participants: 883 students (12-13 years)
Intervention: FATaintPHAT (VETisnietVET in Dutch)
Outcome measures: self-reported behaviours (diet, physical activity, sedentary behaviours) and pedometer counts were measured at baseline, 4-months and 2-years follow-up; BMI, waist circumference and fitness were measured at baseline and 2-years follow-up. Descriptive and multilevel regression analyses were conducted among the total study population and among the students not meeting behavioural recommendations at baseline ('students at risk').
Results: The complete case analyses showed that FATaintPHAT had no effect on BMI and waist circumference. However, the intervention was associated with a lower odds (0.54) of drinking more than 400ml of sugar-sweetened beverages per day, and with lower snack intake (b=-0.81 snacks/day), higher vegetable intake (b=19.3 grams/day), but also with a lower step count (b=-10856 steps/wk) at 4-months follow-up. In addition, among students at risk, FATaintPHAT had a positive effect on fruit consumption (b=0.39 grams/day) at 4-months follow-up and on step count (b=14228 steps/wk) at 2-years follow-up, but an inverse effect on the odds of sports participation (OR=0.45) at 4-months follow-up. No effects were found for sedentary behaviour.
Conclusion: FATaintPHAT was associated with positive short-term effects on self-reported dietary behaviours but with unfavourable effects on physical activity among adolescents.

INTRODUCTION

Even though the increase in overweight and obesity prevalence among adolescents seems to level off in some countries, such as the United States and Denmark [1, 2], the high prevalence is still a major public health concern, because of its association with various chronic diseases [3]. Overweight and obesity rates in 12 year olds in the Netherlands in 2003 were 16.4% among boys and 18.1% among girls, which is a substantial increase since 1980 (boys 3.6%, girls 6.5%) and 1997 (boys 8.7%, girls 11.7%) [4]. Continuing preventive action is therefore needed. However, the number of obesity prevention interventions, that have reasonable effect sizes, are suitable and attractive for adolescents and that can reach large numbers of adolescents is limited [5].

A variety of dietary, sedentary and physical activity behaviours have found to be related to overweight among adolescents [6-8], and these are important target behaviours for obesity prevention interventions. To realise improvements in these behaviours adolescents first need to be aware of their risk behaviour [9]. Making people aware of their risk behaviour and guiding them through further phases of behaviour change can be facilitated by personalised feedback and change information. Computer tailoring is a health education technique that is specifically suited to provide this type of feedback to larger numbers of people without the costs associated with interpersonal communication and has been recognised as a promising health communication technique in energy balance related behaviour change [10].

Recent reviews on school-based interventions have shown that some studies found effects on weight related outcomes [11-14]. Combined dietary and physical activity interventions may be the most promising in preventing children becoming overweight in the long term [11, 14-16]. In addition, educational interventions were most likely to show an effect on dietary behaviours [12]. Whether computer-tailored personalised education in the classroom is superior to a generic classroom curriculum has not yet been convincingly demonstrated [11]. Systematic reviews indicate that computer tailoring is likely to be more effective than generic health education for modifying dietary intake [17-19] and possibly physical activity [20] among adults. In previous studies among adolescents, computer-tailored interventions were most frequently implemented as part of a multi-component intervention showing promising results [11, 21, 22]. At present, only few studies have evaluated the single effects of computer-tailored interventions among adolescents [23, 24]. The present study on a standalone computer-tailored intervention can add to the evidence on

the effectiveness of computer tailoring for adolescents to prevent excessive weight gain and improve dietary, physical activity and sedentary behaviours.

We developed an online school-based computer-tailored intervention, named FATaintPHAT (VETisnietVET in Dutch) to prevent excessive weight gain among adolescents through modifying energy balance-related behaviours. The present study aims to evaluate the short and long-term effects among adolescents. The hypotheses were that in the intervention group as compared to the control group:

1. Anthropometric outcomes (BMI, percentage overweight, waist circumference) and fitness will be more favourable at 2-years follow-up;
2. The outcomes on the targeted behaviours (consumption of sugar-sweetened beverages, snacks, fruit, vegetables and fibre, television viewing, computer use, and physical activity behaviours) will be more favourable at 4-months and 2-years follow-up.

METHODS

Study design

A two-group cluster randomised trial (n=883) was conducted with assessments at baseline, 4-months (school year 2006-2007) and 2-years follow-up (school year 2008-2009). Schools were randomised into an intervention or a no-intervention control group after stratification according to educational level (vocational training; pre-university training) using a random number generator. The outcome measures on anthropometrics were assessed at 2-years follow-up and on energy balance-related behaviours at 4-months and 2-years follow-up. The study was approved by the Medical Ethics committee of the Erasmus MC and registered in the Netherlands Trial Registry (ISRCTN15743786). The methods and intervention are described in detail elsewhere [25]. The study was conducted in collaboration with the Municipal Health Services in the Rotterdam area.

Participants and recruitment

Participants, adolescents aged 12–13 years at the start of the study, were recruited in a two-step procedure. First, 88 schools for secondary education in Rotterdam and surrounding municipalities were invited to participate. Twenty-three schools (vocational to pre-university educational) were eligible and willing to participate (Figure 1). Schools were considered eligible when their students were able to read

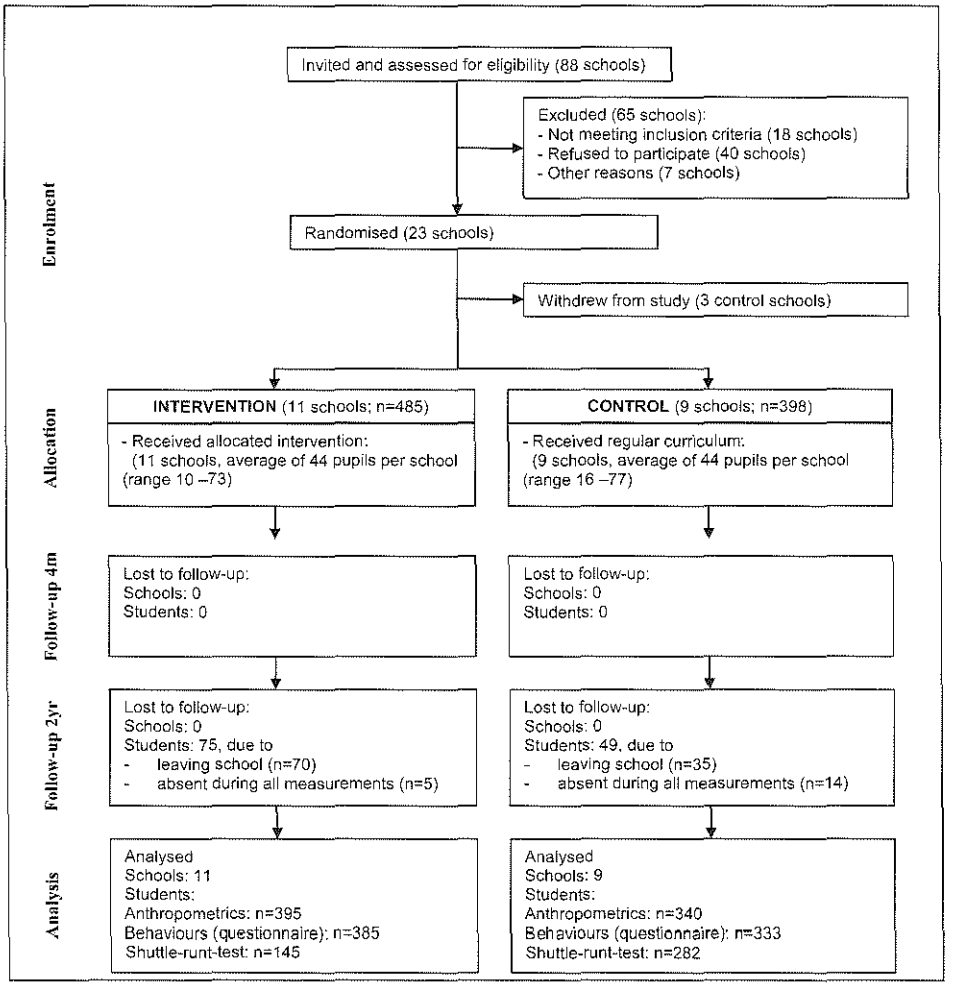

Figure 1 Cluster and participant flow for the FATaintPHAT study

and comprehend the study and intervention materials. Second, adolescents of one to five classes in each school were invited to participate. Students received information and an informed consent form for themselves and their parents. The completed consent forms were returned through the schools. Three schools withdrew from the study after randomization and before the baseline measurement because they found the informed consent procedure too troublesome. Of the 1494 students, 1156 (77%) returned their forms and 883 students (59%) agreed to participate in the study. Students in the intervention group were more likely to participate (33% vs. 26%), even though allocation was concealed until the start of the intervention period.

The intervention

The objective of the computer-tailored intervention was to contribute to the prevention of excessive weight gain among adolescents aged 12 to 13 years by improving dietary behaviours (reducing the consumption of sugar-sweetened beverages and high energy snacks, increasing intake of fruit, vegetables, and whole wheat bread), sedentary behaviour (reducing screen time), and physical activity (increasing active transport to school, leisure time activities and sports). Separate modules (8) addressed the concept of weight management and all energy balance related behaviours. Each module consisted of a brief introduction to the topic with information about the behaviour-health link, an assessment of behaviour and determinants, individually-tailored feedback on behaviour and determinants and an option to formulate an implementation intention to prompt specific goal setting and action planning. The feedback provided included several elements: behavioural feedback, comparing the student's behaviour with guidelines for that behaviour (normative feedback), and with behaviour of peers (comparative feedback), prompts for intention formation, decisional balance information to change attitudes, prompts for barrier identification and instructions on how to perform/change a behaviour to improve self-efficacy, and suggestions on how to organise social support. A multi-theoretical approach, including the Theory of Planned Behaviour [26], the Precaution Adoption Process Model [27] and implementation intentions [28] was used to inform the intervention. To prevent the intervention from inducing worrisome dieting behaviours in adolescents with a low BMI, underweight girls and boys received general information about healthy eating and physical activity. The intervention was accessible through the Internet. The teachers were asked to allocate 15 minutes in eight lessons over 10 weeks for working with the programme according to a teacher manual.

Procedure

The outcome measures were BMI, percentage overweight, waist circumference and fitness (at 2-years follow-up), and energy balance-related behaviours (at 4-months and 2-years follow-up). Data on the outcome measures were collected through anthropometric measurements, questionnaires, pedometers, and shuttle-run tests. Weight, height, and waist circumference were measured by and the questionnaires were administered and completed under the supervision of a research-assistant during school hours. Fitness was measured with a shuttle-run test performed by the physical activity teacher according to a standard protocol. After the baseline assessments, the intervention was implemented by the teachers

during a 10 week period. The control school implemented the regular curriculum without extra activities.

Measurements

Anthropometrics

Height was measured twice without shoes using a Seca 225 mobile height rod with an accuracy of 0.1 cm and the average was calculated. A calibrated electronic digital floor scale (Seca 888 class III) was used to measure the body weight of the students who wore light clothes (shorts and t-shirt or underwear) with an accuracy of 0.2 kilogram. BMI was calculated as weight (kilograms) divided by height (meters) squared. Waist circumference was measured twice using measuring tapes (Seca 201), with an accuracy of 0.1 cm. A third and fourth measurement was taken when the difference between the measures was more than 1.0 cm. The average of the (last) two measurements was calculated.

Self-reported behaviours

Electronic, self-administered questionnaires were used to assess the behaviours (see Appendix). Questionnaires were completed within one school hour; completion time varied between 30 and 60 minutes. Dietary intake was assessed using a 39 item food frequency questionnaire assessing the frequency and quantity of sugar-sweetened beverages, fruit and vegetables eaten in the past week and a self-administered 24-hour recall for snacks, sugar-sweetened beverages, fruit and vegetable consumption. Validated questionnaires were used for snack [29] and fruit and vegetables intake [30, 31] with minor adaptations to fit within the school-based administration. Physical activity and sedentary behaviour were assessed using the Flemish validated questionnaire [32]. Because Flemish Dutch is somewhat different than Dutch as used in the Netherlands, some appropriate language editing was necessary. This questionnaire assessed sports during leisure time, active transportation to school, television viewing, and computer use during leisure time in the past seven days by asking about the frequency and duration of the activities. In addition, the number of days the student spent at least 60 minutes in moderate or vigorous intensity physical activity was assessed. An additional assessment of physical activity was obtained with pedometers (Digiwalker SW200, NewLifelstyles) [33] that were worn by a random sub-sample of 5 students per class for seven consecutive days following the questionnaire assessment.

Values for soft drink, fruit juice, snacks, fruit, vegetables, active transport and sports that exceeded three times the standard deviation (z-score above 3.29), and TV viewing and computer use above 12 hrs/day (week day) and 16 hrs/day (weekend day) were considered to be unreliable and were treated as missing values. Remaining high values were truncated to maximum values as follows: soft drink and fruit juice 3000ml/day; active transport to school 390 min/wk; sports 1200min/wk. Consumption of sugar-sweetened beverages was computed as the sum of soda and fruit juice.

A 24-hour recall is found to be superior over a frequency questionnaire to get reliable estimates of group mean intake levels and to detect differences between groups [34, 35]. Therefore, if available in our dataset, we used 24-hour recall questions for the analyses. If no 24-hour recall was available (i.e. for physical activity, sedentary behaviours, snack and whole wheat bread consumption) we used the frequency and duration/amount of the usual behaviour. The distribution of the outcome variables were inspected for normality, showing that for sugar-sweetened beverage consumption and sports participation the distribution was insufficiently normally distributed. These outcomes were thereupon dichotomised. Usual intake of sugar-sweetened beverages as assessed with the food frequency questions was used to this account because the 24-hour recall does not produce a reliable assessment of usual individual intake levels.

Demographics

Questions on demographics included gender, age, educational level, country of birth and parents' country of birth. Ethnicity was defined according to standard procedures of Statistics Netherlands as either Western (both parents born in Europe, North America, Oceania, Indonesia or Japan) or non-Western (at least one parent born elsewhere).

Physical fitness

The shuttle-run test is a validated test that measures aerobic capacity. To do the test, adolescents have to run back and forth for 20 meters, with an initial running pace of 8.0 km/h and a progressive 0.5 km/h increase of the running speed every minute indicated by a beep sound [36]. The maximal performance is reached when the student does not cross the 20-m line at the moment of the beep for two consecutive runs of 20 meter. The number of minutes ran were registered with a

precision of 0.5 minutes by the teachers. Length of the circuit was measured to correct for gym floor tracks shorter than 20 meters.

Analyses

Logistic regression analyses were used to identify whether there was selective drop-out. Drop-out (yes/no) was used as the dependent variable and gender, education, ethnicity, intervention, BMI at baseline and compliance with recommendations for each behaviour as independent variables.

Descriptive statistics were used to describe the study population in each study arm. Differences between groups at baseline were tested using the nonparametric Kolmogorov-Smirnov test or the Chi-square test. Multilevel linear and logistic regression analyses were used to establish intervention effects. Each outcome measure was regressed on group, (intervention (1) vs. control (0)), the baseline value of the outcome measure and gender (girls (1) vs. boys (0)), education (pre-university (1) vs. vocational (0)), ethnicity (non-Western (1) vs. Western (0)), as potential confounders. Separate analyses were run for the short and the long-term results. The analyses were conducted for the total study population and then repeated for the students not meeting behavioural recommendations at baseline ('at risk'), since students engaging in risk behaviour were expected to benefit more from the intervention. For anthropometric outcomes the risk group included normal, overweight and obese adolescents, since these students received advices to prevent excessive weight gain.

Complete case analyses (reported in the tables) and intention-to-treat analyses, using baseline and last observation carried forward (BOCF; LOCF) procedures, were performed [37]. The multilevel regression analyses were performed in MLwiN 2.02. Other analyses were performed in SPSS 15.0. The significance level was set at .05 and tests were two-sided.

Loss to follow-up

Of the 11 intervention schools with 485 students participating, 75 students (15%) were lost to follow-up (left school or had incomplete data at baseline and follow-up); of the 9 control schools with 398 students participating, 49 students (12%) were lost to follow-up (Figure 1). Loss to follow-up did not differ according to study condition, educational level, ethnicity or gender.

RESULTS

Student characteristics

As shown in Table 1, the intervention group consisted of more vocational schools and vocational-level students, more boys and more non-Western students as compared to the control group. The proportion of students meeting behavioural recommendations for the different energy balance-related behaviours at baseline differed between intervention and control group for physical activity and sedentary behaviour. More students in the intervention group were active for less than 60 minutes per day or engaged less than 2 hours in sedentary behaviour.

Intervention effects

Table 2 shows the mean values for the outcome measures at baseline, 4-months and 2-years follow-up for the intervention and the control group for the total sample and for the students at risk. The regression analyses (Table 3) showed no significant intervention effects on BMI, waist circumference or percentage of students being overweight/obese in the total sample and among normal-weight/overweight/obese students.

At 4-months follow-up the intervention group was less likely to report to drink more than 400 ml of sugar-sweetened beverages per day as compared to the control group in the total sample, but not in the risk group. Mean self-reported snack consumption was lower in the intervention as compared to the control group at 4-months follow-up. The difference at 2-years follow-up was not significant. Among the students at risk, the intervention group reported to eat more pieces of fruit at 4-months follow-up. For vegetable intake, the intervention group reported to consume more grams per day at 4-months follow-up, compared to the control group, in both the total sample and among the students at risk. There were no differences in self-reported consumption of whole wheat bread between intervention and control group.

Among the students at risk, the intervention group was less likely to report to participate in sports at 4-months follow-up than the control group. In the intervention group fewer steps per week were recorded at 4-months follow-up, but more steps at 2-years follow-up (only in the at risk group) compared to the control group.

Table 1 School and student characteristics at baseline for the intervention and control group

	Intervention		Control		
	N	Mean (SD) or %	N	Mean (SD) or %	p-value[a]
School characteristic					
N	11		9		
Educational level					
Vocational (%)	7	64	5	56	
Pre-university (%)	4	36	4	44	
Student characteristics					
N	485		398		
Mean age	482	12.7 (0.7)	398	12.6 (0.6)	.118
Gender					
Boys (%)	284	58.9	198	49.7	**.008**
Girls (%)	198	41.1	200	50.3	
Education					
Vocational (%)	282	62.3	192	50.5	**.001**
Pre-university (%)	171	37.3	188	49.5	
Etnicity					
Western (%)	320	66.0	314	78.9	**.000**
Non-Western (%)	165	34.0	84	21.1	
Weight category[b]					
Underweight (%)	40	9.1	34	9.0	.221
Normal weight (%)	331	75.2	293	77.9	
Overeight (%)	53	12.0	44	11.7	
Obese (%)	16	3.6	5	1.3	
Risk groups for the behaviours					
SSB					
≤ 400ml/day (%)	112	25.6	81	21.9	.215
> 400ml/day (%)	325	74.4	289	78.1	
Snacks					
≤ 3 pieces/day (%)	161	37.3	127	35.0	.553
> 3 pieces/day (%)	271	62.7	236	65.0	
Fruit					
< 2 pieces/day (%)	208	47.1	178	47.8	.877
≥ 2 pieces/day (%)	234	52.9	194	52.2	
Vegetables					
< 200 grams/day (%)	389	87.8	332	87.8	1.000
≥ 200 grams/day (%)	54	12.2	46	12.2	
Whole wheat bread					
Always/mostly (%)	246	56.6	210	57.2	.905
Sometimes/seldom/never (%)	189	43.4	157	42.8	
Physically active					
<60 min/day (%)	229	52.8	155	42.7	**.006**
≥60 min/day (%)	205	47.2	208	57.3	
Sedentary					
≤ 2 hours/day (%)	49	11.6	25	6.9	**.036**
> 2 hours/day (%)	374	88.4	336	93.1	

[a] p-value for the test for a significant difference between intervention and control group. Age by S-K test, categorical data by chi-square test; [b] based on the IOTF cut-off points; N=number of participants; SD=standard deviation; SSB=sugar-sweetened beverages

Table 2 Descriptive means or percentage students for the outcome measures for the intervention (I) and control (C) group, and for the total sample and the students at risk (i.e. being normal/overweight, or not meeting behavioural recommendations)

		Baseline		4-months		2-years	
Outcome		**N**	**Mean (SD) or %**	**N**	**Mean (SD) or %**	**N**	**Mean (SD) or %**
Anthropometrics							
BMI							
all students	I	440	19.48 (3.45)			391	21.08 (3.93)
	C	376	19.23 (2.96)			337	20.67 (3.15)
risk group	I	400	19.91 (3.33)			323	21.36 (3.78)
	C	342	19.62 (2.81)			286	21.11 (3.06)
Weight category[a] : % overweight/obese (vs. normal/underweight)							
all students	I	440	15.7			393	17.8
	C	376	13.0			340	16.2
risk group	I	400	17.3			325	18.8
	C	342	14.3			289	18.0
Waist circumference (cm)							
all students	I	442	67.88 (8.13)			393	74.70 (9.78)
	C	376	66.82 (6.95)			339	73.24 (8.20)
risk group	I	400	68.78 (7.96)			325	75.26 (9.82)
	C	342	67.55 (6.82)			288	73.96 (8.13)
Diet							
SSB (usual): % >400ml/day (vs. ≤ 400ml)							
all students	I	436	74.4	426	64.3	364	71.5
	C	372	78.1	367	75.8	325	72.3
risk group	I	325	100	286	75.5	235	78.3
	C	289	100	262	82.4	237	77.6
Snacks pieces/day (24h recall)							
all students	I	432	5.5 (3.8)	412	4.9 (3.8)	359	5.3 (4.7)
	C	363	5.2 (3.3)	360	5.5 (4.1)	318	5.8 (4.8)
risk group	I	271	7.6 (3.4)	232	5.7 (3.4)	196	6.0 (5.1)
	C	236	6.9 (2.8)	216	6.2 (3.9)	193	6.6 (4.9)
Fruit pieces/day (24h recall)							
all students	I	442	1.67 (1.25)	421	1.74 (1.32)	371	1.48 (1.31)
	C	372	1.63 (1.24)	374	1.58 (1.26)	330	1.46 (1.21)
risk group	I	208	0.60 (0.49)	184	1.33 (1.27)	168	1.25 (1.26)
	C	178	0.61 (0.49)	166	0.96 (1.05)	141	0.95 (0.96)
Vegetables gram/day (24h recall)							
all students	I	443	107 (79)	436	118 (81)	375	106 (76)
	C	378	106 (76)	377	99 (72)	330	105 (75)
risk group	I	389	86 (59)	356	109 (79)	301	101 (72)
	C	332	87 (58)	318	94 (68)	273	104 (74)
Whole wheat bread (usual): % sometimes, seldom, never (vs. always, mostly)							
all students	I	435	43.4	425	40.0	370	40.0
	C	367	42.8	369	40.9	320	37.5
risk group	I	189	100	163	68.7	138	69.6
	C	157	100	140	70.7	126	61.9

Table 2 (continued)

Outcome		Baseline N	Baseline Mean (SD) or %	4-months N	4-months Mean (SD) or %	2-years N	2-years Mean (SD) or %
Physical activity (last week)							
number of days 60 minutes moderately active							
all students	I	453	2.61 (1.92)	444	2.95 (2.02)	383	2.46 (1.90)
	C	380	2.96 (1.90)	379	3.23 (2.10)	332	2.63 (1.95)
risk group	I	229	2.00 (1.58)	212	2.46 (1.88)	184	2.09 (1.78)
	C	155	2.35 (1.59)	149	2.96 (2.08)	136	2.18 (1.82)
Transport to school (min/week)							
all students	I	452	131 (137)	444	135 (133)	382	132 (130)
	C	380	156 (117)	378	160 (114)	329	161 (113)
risk group	I	229	81 (103)	212	105 (118)	184	104 (120)
	C	155	124 (97)	148	134 (98)	134	137 (97)
Sport outside school: % yes (vs. no)							
all students	I	466	81.8	414	80.4	453	76.4
	C	393	89.3	374	90.9	394	82.0
risk group	I	229	63.8	209	66.5	222	70.3
	C	155	72.9	147	82.3	155	71.0
Steps count (steps/wk)							
all students	I	128	81046 (28987)	116	79350 (25623)	105	78560 (253489)
	C	99	84679 (21697)	85	89934 (29796)	68	68276 (27862)
risk group	I	62	73052 (24049)	58	71007 (20943)	51	71923 (24021)
	C	35	80465 (22335)	40	82672 (27369)	27	59534 (20879)
Fitness							
Shuttle-run-test (minutes)							
all students	I	367	6.4 (2.3)			145	7.5 (2.5)
	C	321	6.8 (2.3)			260	7.9 (2.4)
Sedentary behaviour (last week)							
Television + computer (minutes/day)							
all students	I	423	299.7 (163.6)	404	287.1 (162.3)	355	313.1 (155.6)
	C	361	312.9 (163.9)	358	295.2 (154.6)	316	331.3 (161.7)
risk group	I	374	326.8 (154.5)	316	296.7 (155.3)	277	320.8 (151.1)
	C	336	330.0 (156.8)	307	299.4 (146.6)	263	341.8 (157.8)

[a] based on the IOTF cut-off points; N=number of students in the analyses; SD=standard deviation; SSB=sugar-sweetened beverages.

Intention to treat analyses

Imputation of the 4-months and 2-years follow-up outcomes with BOCF and LOCF procedures resulted in only few differences compared to the complete case analyses presented in the tables. In the at risk group, imputation lead to a significant effect for fruit intake at 2-years follow-up (BOCF b=0.26 (95% CI: 0.01; 0.51)), while the group differences for step count at 4-months follow-up (BOCF b=-7413 (95% CI: -15272;487) and 2-years follow up (BOCF b=2838 (95% CI: -3563; 9272); LOCF b=-5017 (95% CI: -16074;6098)) were non-significant.

Table 3 Intervention effects (regression coefficients (B) or Odds Ratio's (OR) with 95% Confidence Intervals (CI) among all students and students at risk (i.e. being normal/overweight, or not meeting behavioural recommendations)

	4-months				2-years			
Outcome	**N**	**B**	**OR**	**95% CI**	**N**	**B**	**OR**	**95% CI**
Anthropometry								
BMI								
All students					676	0.14		-0.17; 0.45
Risk group					611	0.11		-0.27; 0.49
Weight category[a] (overweight/obese (1); normal/underweight (0))								
All students					676		0.91	0.52; 1.61
Risk group					611		0.91	0.51; 1.62
Waist circumference (cm)								
All students					678	0.60		-0.44; 1.64
Risk group					611	0.55		-0.55; 1.64
Diet								
SSB (ml/day) (>400ml (1); <=400ml (0))								
All students	729		**0.54**	0.34; 0.88	633		1.00	0.68; 1.45
Risk group	548		0.62	0.34; 1.13	472		0.93	0.46; 1.90
Snacks (pieces/day)								
All students	714	**-0.81**		-1.33; -0.29	619	-0.66		-1.35; 0.04
Risk group	448	**-0.97**		-1.70; -0.24	389	-0.90		-1.85; 0.05
Fruit (pieces/day)								
All students	742	0.11		-0.08; 0.31	649	0.06		-0.13; 0.24
Risk group	350	**0.39**		0.13; 0.66	309	0.24		-0.13; 0.63
Vegetables (gram/day)								
All students	765	**19.34**		7.54; 31.21	659	-2.42		-18.12; 13.36
Risk group	674	**16.72**		5.43; 28.07	574	-5.15		-22.75; 12.55
Whole wheat bread (always, mostly (1); sometimes, seldom, never (0))								
All students	730		1.08	0.67; 1.75	642		0.85	0.57; 1.26
Risk group	303		1.06	0.63; 1.78	264		0.74	0.41; 1.29
Physical activity (last week)								
number of days 60 minutes active								
All students	780	-0.21		-0.54; 0.13	678	-0.13		-0.41; 0.16
Risk group	361	-0.46		-0.98; 0.08	320	-0.03		-0.42; 0.37
Transport to school (min/wk)								
All students	779	-10.7		-28.2; 6.8	674	-14.5		-37.2; 8.2
Risk group	360	-0.9		-21.5; 19.8	318	-9.4		-34.5; 15.8
Sport outside school (yes=1; no=0)								
All students	726		0.54	0.30; 1.00	631		0.81	0.53; 1.23
Risk group	356		**0.45**	0.24; 0.85	313		1.18	0.67; 2.05
Steps count (steps/wk)								
All students	136	**-10856**		-21556;-101	80	8611		-2296;19574
Risk group	65	**-13636**		-23938; -3281	34	**14228**		678; 27838

Table 3 (continued)

	4-months				2-years			
Outcome	**N**	**B**	**OR**	**95% CI**	**N**	**B**	**OR**	**95% CI**
Fitness								
Shuttle-run-test (minutes)								
All students					353	0.03		-0.95; 1.01
Risk group					312	-0.19		-1.14; 0.77
Sedentary behaviour (last week)								
Television + computer (min/day								
All students	688	-5.4		-25.2; 14.5	602	-16.6		-43.4; 10.4
Risk group	623	-4.1		-25.5; 17.5	540	-21.7		-47.8; 4.6

All multilevel linear and logistic regression analyses were adjusted for gender, education, ethnicity and the baseline value of each outcome. Beta or odds ratio indicate comparison with the control group. All 20 clusters are in the analyses, except for fitness (14 clusters all students; 13 clusters risk group) and step count (18 clusters 4-months follow-up risk group; 18 clusters 2-years follow-up all students; 14 clusters 2-years follow-up risk group) ; SSB=sugar-sweetened beverages.

DISCUSSION

Main results

The results indicate that FATaintPHAT had no effects on anthropometric outcomes. We found favourable effects on self-reported obesity-related dietary behaviours at 4-months follow-up, but not at 2-years follow-up. No effects for sedentary behaviours and some unfavourable effects for physical activity behaviours (sports participation and step counts) at 4-months follow-up were found.

Interpretation of the results

Anthropometrics and fitness were only measured at two year follow-up, while behavioural effects were only found at 4 months follow-up. The intervention thus appears to be not strong enough to have sustained effects, possibly due to its short duration (8 sessions of 15 minutes within 10 weeks). Furthermore, the 4 months changes in behaviour were not all in the desired direction, making changes in body composition and fitness less likely.

It is, however, promising that we did find positive effects on dietary behaviours at 4-months follow-up. These findings compare positively with the effects that have been found in previous comparable studies, both in terms of number of effects and the sizes of the effects. Haerens et al. [21, 38] found a decrease in fat intake, at one and two years follow-up, but not on sugar-sweetened beverages, fruit and water

consumption. The 1-school year healthy eating promotion intervention combined environmental changes, computer-tailored feedback and a parent component. Singh et al. [22] did not find effects on snack consumption, but they did find a decrease in sugar-sweetened beverages consumption after 8 and 12 months of about 250 ml difference between groups; they did not find an effect after 20 months. The 1-school year intervention to prevent excessive weight gain among adolescents consisted of an educational (11 lessons) and environmental component. Martens et al. [39] did not find a significant effect for fruit intake nor on breakfast consumption, but they did find a decrease in snacks consumption (0.6 pieces) at 3 months post baseline. The dietary intervention consisted of an educational (8 lessons) and parental component. Knai et al. [40] found in their review on fruit and vegetable consumption that of the four identified interventions, two did not find significant effects after three years, one found an increase of 0.3 servings per day among girls after two years, and one study found an increase of 0.9 servings per day at interim evaluation but no effect at 2-year follow-up. Muth et al. [41] found an increase of 0.9 servings of fruit and vegetables per day directly after the intervention period. It is noteworthy that these other interventions were all high intensity programmes that comprised of more components than only tailored feedback. Analyses with imputed outcomes for fruit consumption at two year follow-up led to a similar effect compared to the non-imputed results, although the imputed effect was just significant.

The adverse effect on some physical activity indicators was unexpected and is worrisome. These adverse effects were mainly caused by a larger increase in sports participation (students at risk: 73 to 82%) and step counts in the control group (all students: 84500 to 90000; students at risk: 80500 to 82500 steps) as compared to the intervention group (64 to 67%; 81000 to 79500 steps; 73000 to 71000 steps). The increase in physical activity in the control group might be due to seasonal influences over the 4 month period (fall/winter – spring/summer) [42], an increase that we at least would have expected to see in the intervention group as well. The findings may indicate that the intervention inhibited the adolescents from increasing their levels of physical activity. This inhibition effect might be the result of unexpected reactions to the feedback messages. Currently, there is limited evidence for the way adolescents respond to personalised feedback [43]. More insight in the processing of feedback messages is therefore needed to be able to improve interventions. Finally, we cannot rule out that students might have compensated their improved dietary behaviours by lowering physical activity, although additional analyses of our data do not reveal such compensating associations. Better understanding of possible compensating processes when multiple

behaviours are targeted might help the tailoring field move forward. Imputation of step count led to non-significant effects. As might be expected, BOCF imputation led to smaller effect sizes [37], while LOCF imputation led to effects that were more comparable with outcomes at second follow-up since any effects on first follow-up are carried forward. We did not observe differences in mean step count for the imputed and the non-imputed participants. However, we assessed step counts in a subsample of students and therefore the number of observations is small and number of imputations is relatively large. Therefore, we should interpret the results on step count cautiously. We did not find any effects on sedentary behaviours. This might be explained by the fact that the sedentary behaviour module was less well appreciated compared to the other modules (data not presented), although slightly around the middle category on a five point scale.

Effects of computer-tailored interventions for dietary, physical activity and sedentary behaviours among adolescents have not been studied extensively. Haerens et al. showed that a computer-tailored intervention for increasing physical activity among adolescents was more effective compared to a no-intervention control group [23], but not more effective compared to generic information [24]. De Bourdeaudhuij et al. [11], based on a systematic review including multi-component interventions, concluded that computer-tailored personalised education in the classroom might have led to better results than a generic classroom curriculum in school-based nutrition and physical activity interventions. Our study indicates adverse effects on physical activity, but a favourable impact on dietary behaviours among adolescents. This is largely in line with the conclusions of recent reviews [17, 18, 20] that found convincing evidence for the effectiveness of computer-tailored interventions on diet, but inconclusive results for physical activity among adults. However, because the control group was exposed to the regular school curriculum in our study, it remains unclear if the effects are due to the tailoring strategy used in the intervention.

Our intervention may benefit from improvements that have been suggested in recent study reports. It has been shown that interventions with a longer duration (>1 year) are more effective as compared to interventions with a shorter duration (<6 months) [5]. In addition, adding intervention components that intervene on other determinants than only individual level determinants might increase the effectiveness of the intervention. For instance, combining the FATaintPHAT intervention with a physical activity programme might increase the effectiveness. Two reviews [5, 44] showed that interventions that used both physical activities and classroom teachings about proper nutrition and physical activity were more ef-

fective in reducing childhood obesity compared with those that involved either physical activity or classroom teachings. Another possibility is to target the home environment/parents or the school environment [5] or to provide environmental information within computer-tailored programmes to influence the perceived environment [45]. Thus, our intervention may benefit from increasing the duration and from adding components that target different settings such as the school or home environment.

Strengths and limitations

Important strengths of this study are its randomised design, large size, objective measures for anthropometry and physical activity and the novelty of addressing the effectiveness of a standalone computer-tailored intervention. Limitations to the study are the use of self-reported measures, which may have resulted in less reliable outcomes and have weakened the effects found in this study. In addition, more students from the intervention group were lost to follow-up, which may also have been due to the over representation of vocational schools in this group. Vocational school students choose their specialty after two years and therefore often change to a different school location. Since the pedometers were used in a subsample of students and there was some loss to follow-up, the number of adolescents that used the pedometer at the second follow-up was small compared to the baseline and first follow-up. Therefore, results should be interpreted with care.

Conclusion

This paper shows that the computer-tailored intervention FATaintPHAT was not effective in modifying anthropometric outcome measures, but that it can have a positive effect on dietary behaviours among adolescents at short-term follow-up. Expanding the intervention with additional components or booster sessions might improve the effectiveness in the short and long term. However, this study also showed that a computer-tailored intervention can have unexpected and undesired effects on physical activity behaviour, which stresses the importance of careful evaluation and in-depth study of how computer-tailored feedback works for adolescents.

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Appendix Questionnaire items and answering categories used to examine energy balance-related behaviours

Question	Answering categories
Consumption of sugar-sweetened beverages	
How many days did you drink soft drinks/fruit juice last week?	none, 1, 2, 3, 4, 5, 6, 7
On days that you drank soft drinks/fruit juice, how many glasses/ bottles/cans did you drink?	none, 1, 2, 3, 4, 5, 6, 7+ glasses/bottles/cans per day
Consumption of snacks	
How many	
warm snacks/	none, 1, 2, 3, 4, 5, 6, 7+
nuts/	none, 1, 2, 3, 4, 5, 5+ hands
chips/	none, 1 (30gr), 2, 3, 4 (125gr), 5, 6, 7 (200gr), 8, 9, 10 (300gr), 10+ portions
cheese/	none, 1, 2, 3, 4, 5, 5+ pieces
pastry/	none, 1, 2, 3, 4, 5, 5+ pieces
candy bars/	none, 1, 2, 3, 4, 5, 5+ pieces
chocolate/	none, <quarter, quarter, half, whole (75-100gr), one and a half, more than one and a half bar
cookies/	none, 1, 2, 3, 4, 5, 6, 7+
candy did you eat yesterday? (in between meals)	none, 1-9, 10-19, 20-29, 30+ sweets
Consumption of fruit	
How many pieces of fruit did you eat yesterday?	none, 1, 2, 3, 4, 5, 6, 7+ pieces
Consumption of vegetables	
How many spoons cooked, baked, steamed, warm vegetables/salad did you eat yesterday?	none, 1, 2, 3, 4, 5, 6, 7+ spoons
Consumption of whole wheat bread	
When you eat bread, do you eat the whole wheat variety?	never, almost never, sometimes, often, always
Physical activity – no. of days 60 min. moderately active	
How many days of a usual week are you moderately physical active during at least 60 minutes per day?	none, 1, 2, 3, 4, 5, 6, 7 days
Physical activity - active transport to school (think about last week)	
How do you usually go to school?	bike, walking, car/train/bus, step/ roller skates /skeelers
How many minutes do you bike/walk to school?	open answer (minutes from home to school)
Are you going home during the school day?	yes, no
On which days are you going home during the school day?	Monday, Tuesday, Wednesday, Thursday, Friday
Physical activity – sports participation	
What is your sport no. 1/2/3?	no, open answer
Do you perform this sport every week	yes, no
How many times per week do you perform this sport? OR	1, 2, 3, 4, 5, 6, 7, more than 7 days
How often do you perform this sport?	few times per year, 1, 2, 3 times per month
How long do you perform this sport each time?	open answer (hours, minutes)
Sedentary behaviour	
How many hours per day do you usually watch television/use the computer (weekdays/weekend days)?	open answer (hours, minutes)

Question or answering items divided by a "/" were assessed separately

Chapter 7

Differential effects of the computer-tailored FATaintPHAT program on dietary behaviours, according to socio-demographic, cognitive and home environmental factors

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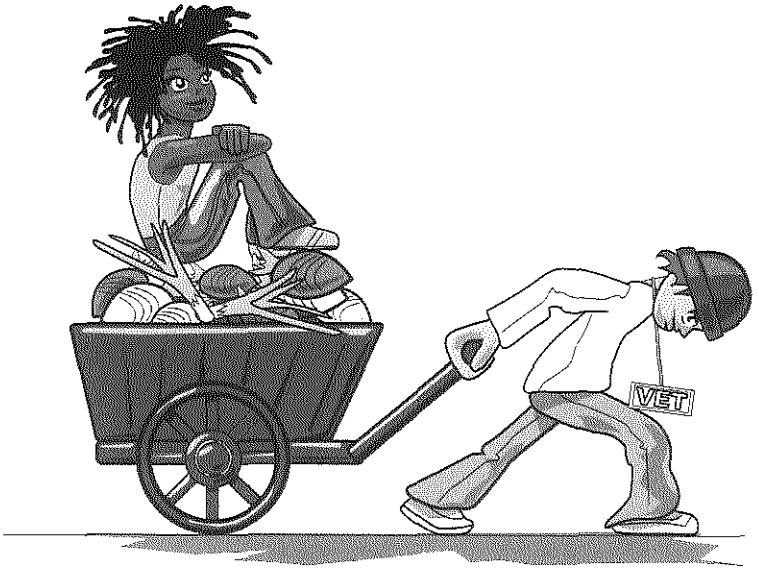
Submitted for publication



ABSTRACT

Purpose: To explore whether the effects of FATaintPHAT, a computer-tailored intervention aimed to prevent excessive weight gain among adolescents, on dietary behaviours were moderated by socio-demographic, cognitive and home environmental factors. Studying potential differential effects of computer-tailored interventions may increase our understanding of subpopulations not served, as well as ways to optimize interventions.

Methods: A two-group cluster randomized trial among 883 students (12-13 years) from 20 schools in the Netherlands. Outcome measures (sugar-sweetened beverage, snack, fruit and vegetable consumption) and potential moderators were assessed using self-report questionnaires. Moderation by gender, education level, ethnicity, awareness of risk behaviour, intention and home availability was assessed using multilevel regression analyses and subsequent stratified analyses.

Results: Of the 24 interactions tested only 3 were significant. The intervention effect on sugar-sweetened beverages was moderated by level of education (p=.009); intervention effects were found among pre-university students but not among students in vocational training. The intervention effects on fruit and vegetables intake were moderated by awareness of fruit intake (p=.000) and home availability of vegetables (p=.007), respectively; an effect on fruit intake was only found among students who were aware of their low fruit intake at baseline. An effect on vegetable consumption was only found among students who reported that vegetables were always available at their home.

Conclusions: The intervention was in general effective among all socio-demographic sub-groups. The significant moderation by home availability illustrates that the environment can influence the effects of educational interventions and future research could explore this possible moderation by environmental factors more often.

INTRODUCTION

It is essential to understand for whom and in what circumstances behaviour change interventions are effective in order to increase our understanding of behaviour change processes, to identify underserved populations, and to be able to optimize interventions [1-3]. Studies investigating potential moderators of intervention effects are needed to provide such information [1, 2]. A moderator or effect modifier of an intervention effect refers to variations in the magnitude of this effect across different sub-populations or circumstances [4]. Only in case of significant moderating variables – tested by assessing the significance of the group*moderating variable interaction term – stratified analyses should be performed [1, 2]. To contribute to the evidence regarding moderators of computer-tailored interventions, we investigated whether the effects of the computer-tailored FATaintPHAT intervention on dietary behaviours that have been found in a previous study (see Chapter 6) were moderated by socio-demographic, cognitive and home environmental factors.

FATaintPHAT is a school-based intervention that consists of eight modules on energy balance-related behaviours [5]. The dietary behaviours addressed in separate modules include the consumption of sugar-sweetened beverages, high energy snacks, fruits, and vegetables. Each intervention module consisted of a brief introduction to the topic with information about the behaviour-health link, an assessment of behaviour and determinants, individually-tailored feedback on behaviour and determinants and an option to formulate an implementation intention to prompt specific goal setting and action planning (see Chapter 5). The intervention was found to be effective in improving sugar-sweetened beverage (Odds Ratio (OR) 0.54 of drinking more than 400ml of sugar-sweetened beverages per day), snack (regression coefficient b= -0.81 snacks/day) and vegetable (b=0.39 grams/day) consumption among adolescents in a cluster randomized trial conducted between 2006 and 2009 in schools in the larger Rotterdam area in the Netherlands (see Chapter 6). The intervention also targeted physical activity and sedentary behaviours, but was not successful in promoting these behaviours. Computer tailoring is a technique that provides individualized feedback and behaviour change information adapted to unique characteristics of a person [6]. Although such interventions are tailored to personal characteristics, this does not necessarily mean that these interventions are equally effective across subgroups with different characteristics. Subgroups that differ in motivation, abilities or opportunities to engage in the recommended behaviour changes, may respond differently to computer-tailored education [7]. However, little research has been conducted to test potential moderators of computer-tailored intervention ef-

fects [7-9], and to our knowledge there are no studies that have investigated this among adolescents.

First of all, effects of interventions like FATaintPHAT may vary according to socio-demographic factors like level of education, gender and ethnicity. If so, there might be socio-demographic subgroups for which we should develop computer tailoring algorithms that incorporate specific characteristics of this sub-group. Differences in effectiveness of computer tailoring according to educational level have been reported before for adults [7, 8]. Furthermore, an important aim of the FATaintPHAT program was to improve adolescents' awareness about their dietary intake. The Precaution Adoption Process Model states that awareness of one's own behaviour is an important first step in the behaviour change process [10]. Adolescents who are already aware of their unhealthy dietary intake or who are already motivated to change may have higher attention to and may be more receptive to feedback messages fostering motivation and self-efficacy and hence are more likely to move into the action phase than adolescent who are unaware or not yet motivated to change [11]. Furthermore, behaviour change is expected to be more likely in a facilitating environment, i.e. where the healthy behavioural options are more and unhealthy options less easily available and accessible [12-14]. For adolescents a supportive and facilitating home environment is likely to be of crucial importance where dietary behaviour is concerned [15].

This paper therefore aims to study whether the effects of FATaintPHAT on sugar-sweetened beverage, snack, fruit and vegetable consumption were moderated by socio-demographic (gender, educational level, ethnicity), personal (awareness, intention), or environmental (availability at home) factors (Figure 1). Our hypotheses were that:

1. gender, level of education and ethnicity do not significantly moderate the intervention effects, because by using the technique of computer tailoring differences according to socio-demographic factors should have been taken into account;
2. awareness and motivation will significantly moderate the intervention effects, because students with higher awareness and more positive intentions are expected to be more ready to change;
3. perceived home availability will significantly moderate the intervention effects, because high availability of healthful and low availability of less healthful dietary options is expected to facilitate making changes in the behaviours that are addressed in the intervention.

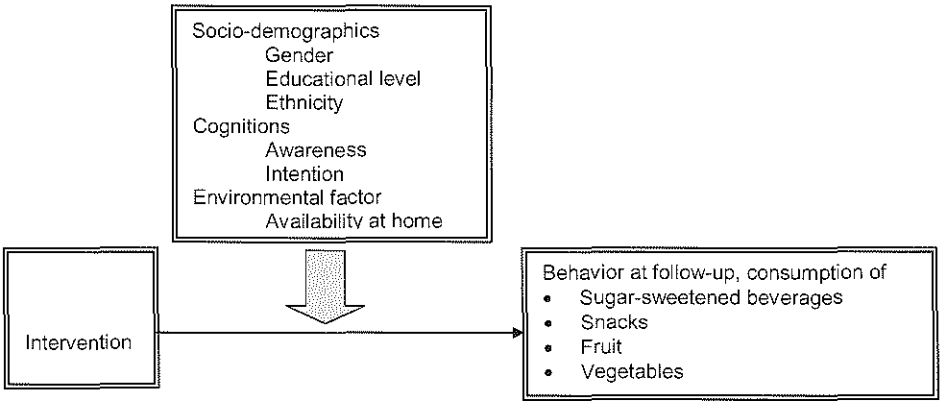


Figure 1 Hypothetical model of potential moderators of the FATaintPHAT intervention effects on dietary behaviours

METHODS

Study design

The FATaintPHAT intervention was evaluated in a two-group cluster randomized trial (n=883) [5] with assessments at baseline and 4-months follow-up (school year 2006-2007). The present study draws on data from this trial. Participants were adolescents aged 12 – 13 years, from 20 schools in the Rotterdam area. Schools were randomly assigned to the intervention group or no intervention control group. The outcome measures were the consumption of sugar-sweetened beverages, high calorie snacks, fruit and vegetables. The study was approved by the Medical Ethics committee of the Erasmus MC and registered in the Netherlands Trial Registry (ISRCTN15743786). The study was conducted in collaboration with the Municipal Health Services in the Rotterdam area.

Participants and recruitment

Participants for the trial were recruited in a two-step procedure. First, 88 schools for secondary education in Rotterdam and surrounding municipalities were invited to participate. The Rotterdam area is characterized by its large diversity in ethnic groups, with particularly large groups from Moroccan, Turkish and Cape-Verdean origin [16]. Twenty-three schools (vocational to pre-university education) were eligible and willing to participate. Second, adolescents of one to five classes in each school were invited to participate. Schools were randomly assigned to either the intervention or control group, after stratification according to educational

level (vocational; higher than vocational). Three schools withdrew from the study after randomization and before the baseline measurement because they found the informed consent procedure too troublesome. Students received information and an informed consent form for themselves and their parents. Completed consent forms were returned by 883 students.

The intervention

The objective of the computer-tailored intervention was to contribute to the prevention of excessive weight gain among adolescents aged 12 to 13 years by improving dietary behaviours (reducing the consumption of sugar-sweetened beverages and high energy snacks, increasing intake of fruit, vegetables, and whole wheat bread), sedentary behaviour (reducing screen-time), and physical activity (increasing active transport to school, leisure time activities and sports). Separate modules addressed the concept of weight management and all energy balance-related behaviours. Each module consisted of a brief introduction to the topic with information about the behaviour-health link, an assessment of behaviour and determinants, individually-tailored feedback on behaviour and behavioural determinants and an option to formulate an implementation intention to prompt specific goal setting and action planning. The feedback provided included several elements: behavioural feedback, comparing the student's behaviour with guidelines for that behaviour (normative feedback), and with behaviour of peers (comparative feedback), decisional balance information to change attitudes, prompts for barrier identification and instructions on how to perform/change a behaviour to improve self-efficacy, suggestions on how to organize social support and prompts for intention formation. A multi-theoretical approach, including the Theory of Planned Behaviour [17], the Precaution Adoption Process Model [10] and implementation intentions [18] was used to inform the intervention. The teachers were asked to allocate 15 minutes in eight lessons over 10 weeks for working with the program according to a teacher manual.

Procedure

Data on the outcome measures were collected through electronic, self-report questionnaires that were completed by the adolescents during one school hour under the supervision of a research-assistant. The same procedure was employed at baseline and four-month follow-up assessment. Weight and height were measured by a trained research-assistant at baseline. After the baseline assessments,

the intervention was implemented by the teachers during a 10 week period. The control schools continued with the regular curriculum without extra activities.

Measurements

Self-reported behaviours

Dietary intake was assessed using a 39-item food frequency questionnaire assessing the frequency and quantity of sugar-sweetened beverages, fruit and vegetables consumed in the past week and a self-administered 24-hour recall for snacks, sugar-sweetened beverages, fruit and vegetable consumption. Validated questionnaires were used for snack [19] and fruit and vegetables intake [20, 21], with minor adaptations to fit within the school-based administration. Questionnaire items are presented in table 1. All dietary data were expressed as intake per day. Values for sugar-sweetened beverages (both soda and fruit juice), snacks, fruit and vegetables that exceeded three times the standard deviation (z-score above 3.29) were considered unreliable and were treated as missing values. Remaining high values for soda and fruit juice were truncated to maximum values of 3000ml/day

Table 1 Questionnaire items and answering categories used to examine dietary behaviours

Question	Answering categories
Consumption of sugar-sweetened beverages	
On how many days did you drink soft drinks/fruit juice last week?	none, 1, 2, 3, 4, 5, 6, 7
On day that you drank soft drinks/fruit juice, how many glasses/ bottles/cans did you drink?	none, 1, 2, 3, 4, 5, 6, 7+ glasses/bottles/cans per day
Consumption of snacks	
How many	
warm snacks/	none, 1, 2, 3, 4, 5, 6, 7+
nuts/	none, 1, 2, 3, 4, 5, 5+ hands
crisps/	none, 1 (30gr), 2, 3, 4 (125gr), 5, 6, 7 (200gr), 8, 9, 10 (300gr), 10+ portions
cheese/	none, 1, 2, 3, 4, 5, 5+ pieces
pastry/	none, 1, 2, 3, 4, 5, 5+ pieces
candy bars/	none, 1, 2, 3, 4, 5, 5+ pieces
chocolate/	none, <quarter, quarter, half, whole (75-100gr), one and a half, more than one and a half bar
cookies/	none, 1, 2, 3, 4, 5, 6, 7+
candy did you eat yesterday? (in between meals)	none, 1-9, 10-19, 20-29, 30+ sweets
Consumption of fruit	
How many pieces of fruit did you eat yesterday?	none, 1, 2, 3, 4, 5, 6, 7+ pieces
Consumption of vegetables	
How many spoons cooked, baked, steamed, warm vegetables/salad did you eat yesterday?	none, 1, 2, 3, 4, 5, 6, 7+ spoons

(baseline: N=23; follow-up N=29). Sugar-sweetened beverages was computed as the sum of soda and fruit juice.

A 24-hour recall is found to be superior over a frequency questionnaire to get reliable estimates of group mean intake levels and to detect differences between groups [22, 23]. Therefore, if available in our dataset, we used 24-hour recall data for the analyses. If no 24-hour recall was available (i.e. for snack consumption) we used the data from the food frequency questionnaire (frequency of consumption x amount). The variable for sugar-sweetened beverage consumption was insufficiently normally distributed and therefore a dichotomized variable was used in the analyses (≤400ml/day vs. >400ml/day). Because a dichotomized 24-hour recall does not produce a reliable assessment of usual individual intake levels, usual intake of sugar-sweetened beverages as assessed with the food frequency questions was used.

Moderating variables

Questions on socio-demographics included gender, age, educational level, country of birth and parents' country of birth. Ethnicity was defined according to standard procedures of Statistics Netherlands as either Western (both parents born in Europe, North-America, Oceania, Indonesia or Japan) or non-Western (at least one parent born elsewhere). Educational level was defined as vocational or pre-university (preparatory for bachelor education). A variable for awareness of risk behaviour was calculated based on perceived intake of the various food products and the measure of actual intake. Perceived intake was assessed as 'Do you think you usually drink/eat small or large amounts of soda/snacks or candy/ fruit/vegetables?' (very little (-2) - very much (+2) amounts). To create an indicator of awareness of risk behaviour, the intake measure was dichotomized indicating compliance with the recommended intake level of each product according to cut-off levels as also used in the intervention (≤400ml sugar-sweetened beverages vs. >400ml; ≤3 pieces of snacks vs. >3; <2 pieces of fruit vs. ≥2; <200grams of vegetables vs. ≥200). Participants were then categorized as aware of their unhealthy behaviour vs. all others (aware of healthy behaviour and unaware respondents). Intention to change was assessed with one 5-point scale item for each behaviour: 'Do you intend to drink/eat less soda/ less candy or snacks/ more fruit/ more vegetables in the next year?' (certainly not (-2) - certainly yes (+2)). This variable was then dichotomized into a negative/neutral intention (-2 – 0) and a positive intention (1 – 2). Availability of food at home was assessed with one item per behaviour (e.g. Are sugar-sweetened beverages available at home? Never, seldom,

sometimes, almost always, always). Because of few observations in the 'never' and 'seldom' answering categories of the availability variable, the categories never, seldom, and sometimes were combined into one category (resulting in a variable with three answering categories) that was used for the stratified analyses.

Weight status

Height was measured twice without shoes using a Seca 225 mobile height rod with an accuracy of 0.1 cm and the average was calculated. A calibrated electronic digital floor scale (SECA 888 class III) was used to measure the body weight of the students who wore light clothes (shorts and t-shirt or underwear) with an accuracy of 0.2 kilogram. BMI was calculated as weight (kilograms) divided by height squared (meters). Weight categories were defined according to the cut-off point defined by the International Obesity Task Force [24].

Analyses

Descriptive statistics were used to describe the study population in each study arm. Differences between the groups at baseline were tested using the nonparametric Kolmogorov-Smirnov test or the Chi-square test. Analyses were performed in SPSS 15.0. The significance level was set at .05 and tests were two-sided.

Moderation was tested by assessing the significance of the group*potential moderator interaction term in multilevel linear and logistic regression models. Each outcome measure (sugar-sweetened beverage, snack, fruit and vegetable consumption) was regressed on group (intervention/control), the baseline value of the outcome measure, gender (girls/boys), education (pre-university/vocational), ethnicity (non-Western/Western), the potential moderator and the group*potential moderator interaction terms in separate analyses. The interaction terms were intervention*gender, intervention*education, intervention*ethnicity, intervention*awareness, intervention*intention and intervention*home availability. Since interaction terms have less power, p- values of interaction terms are commended to be set at 0.10 [25]. If significant, data were stratified according to the levels of the moderators and intervention effects were re-examined in the subgroups [26]. The multilevel regression analyses (with school as level) were performed with proc mixed in SAS 9.2.

RESULTS

Student characteristics

As shown in table 2, the intervention group consisted of more boys, more vocational-level students, and more non-Western students as compared to the control group.

Moderation by socio-demographic factors

Of the twelve potential socio-demographic moderation tests (3 possible moderators x 4 behaviours) one was statistically significant. Education moderated the intervention effect on sugar-sweetened beverage consumption (group*education: p= .009) (Table 3). Pre-university students in the intervention group were 0.32 times less likely to drink more than 400ml of sugar-sweetened beverages per day, while there was no significant effect among vocational students (Table 4 and 5).

Moderation by cognitions

Of the eight potential cognitive variable moderation effects (2 possible moderators x 4 behaviours) only one was statistically significant. Awareness moderated

Table 2 Student characteristics at baseline for the intervention (n=485) and control (n=398) group

	Intervention		Control		
	N	Mean (SD) or %	N	Mean (SD) or %	p-value[a]
Mean age	482	12.7 (0.7)	398	12.6 (0.6)	.118
Gender					
Boys (%)	284	58.9	198	49.7	.008
Girls (%)	198	41.1	200	50.3	
Education					
Vocational (%)	282	62.3	192	50.5	.001
Pre-university (%)	171	37.3	188	49.5	
Ethnicity					
Western (%)	320	66.0	314	78.9	.000
Non-Western (%)	165	34.0	84	21.1	
Weight status[b]					
Underweight (%)	40	9.1	34	9.0	.221
Normal weight (%)	331	75.2	293	77.9	
Overweight (%)	53	12.0	44	11.7	
Obese (%)	16	3.6	5	1.3	

[a] p-value for the test for a significant difference between intervention and control group. Age by S-K test, categorical data by chi-square test; [b] based on the IOTF cut-off points; N=number of participants; SD=standard deviation

Table 3 P-values of the interaction terms from the regression analyses to test for the significance of the potential moderators

	SSB[a]		Snacks[b]		Fruit[c]		Vegetable[d]	
Moderator	**N**	**p-value[e]**	**N**	**p-value[e]**	**N**	**p-value[e]**	**N**	**p-value[e]**
Gender	729	0.468	714	0.801	742	0.281	765	0.358
Educational level	729	**0.009**	714	0.949	742	0.735	765	0.813
Etnicity	729	0.904	714	0.453	742	0.661	765	0.394
Intention	729	0.141	713	0.162	741	0.733	761	0.170
Awareness	729	0.732	714	0.733	731	**0.000**	764	0.329
Home availability	729	0.124	714	0.379	741	0.382	764	**0.009**

[a] SSB (sugar-sweetened beverages (usual): % >400ml/day (vs. ≤ 400ml); [b] Snacks pieces per day (24h recall); [c] Fruit pieces/day (24h recall); [d] Vegetable gram/day (24h recall); [e] p-value group*moderator interaction

Table 4 Descriptives (means and standard deviations (SD) or percentages) for sugar-sweetened beverage (SSB), fruit and vegetable consumption for each level of the moderator variable in the intervention (I) and the control (C) group at baseline and follow-up

		Baseline			4-months		
Outcome		**N**	**Mean or %**	**SD**	**N**	**Mean or %**	**SD**
SSB (usual): % >400ml/day (vs. ≤ 400ml)							
Education							
Vocational students	I	268	82.8%		201	75.8%	
	C	185	84.3%		182	78.6%	
Pre-university students	I	169	60.9%		164	45.7%	
	C	185	71.9%		181	72.9%	
Fruit pieces/day (24h recall)							
Awareness							
Aware of low intake	I	159	0.92	0.89	142	1.35	1.22
	C	152	0.88	0.89	144	0.81	0.85
Unaware of low intake or high intake	I	277	2.09	1.21	247	1.89	1.27
	C	215	2.11	1.12	206	2.03	1.21
Vegetable gram/day (24h recall)							
Home availability							
Never, seldom sometimes	I	76	60.7	62.6	68	86.8	85.3
	C	39	87.5	90.7	35	110.6	87.3
Almost always	I	152	110.9	87.4	139	108.2	74.7
	C	156	88.5	70.3	149	88.9	70.0
Always	I	215	119.7	73.1	205	136.1	80.7
	C	182	124.5	74.3	176	104.2	69.5

Only the stratified descriptives according to the different levels of the statistically significant moderators are presented

the intervention effect of fruit consumption (group*awareness: p= .000) (Table 3). Adolescents in the intervention group who were aware of their low fruit intake at baseline increased their fruit consumption with 0.51 pieces per day compared to students in the control group, while there was no effect among students unaware of their low intake or students with baseline intake of more than 2 pieces per day (Table 4 and 5).

Table 5 Regression coefficients (B) and Odds Ratio's (OR) with the 95% Confidence Intervals (CI) from the stratified analyses of intervention effects on sugar-sweetened beverage (SSB), fruit and vegetable consumption for the various levels of the significant moderator variables

Outcome	N	B	OR	95% CI
SSB (ml/day) (>400ml (1); <=400ml (0))				
Education				
Vocational students	402		0.75	0.37; 1.50
Pre-university students	327		0.32	0.19; 0.52
Fruit (pieces/day)				
Awareness				
Aware of low intake	285	0.51		0.26; 0.77
Unaware of low intake or high intake	446	-0.14		-0.41; 0.12
Vegetable (gram/day)				
Home availability				
Availability: never, seldom, sometimes	103	-30.2		-64.2; 3.8
Availability: almost always	287	18.6		-3.0; 40.2
Availability: always	374	32.9		12.6; 53.1

Only the results of the stratified analyses according to the significant moderators of the intervention effect for the outcomes behaviours are presented

Moderation by home availability

Of the four potential moderation tests by home availability (1 possible moderator x 4 behaviours) one was statistically significant. Home availability moderated the intervention effect on vegetable consumption (group*availability: p= .007) (Table 3). Adolescents in the intervention group who perceived that they had always vegetables at home increased their vegetable consumption with 33 grams per day compared to the control group, while there was no significant intervention effect among students that perceived there were never, seldom, sometimes or almost always vegetables at home (Table 4 and 5).

DISCUSSION

Main findings

The exploration of potential moderation of intervention effects by socio-demographic, cognitive and environmental factors for four dietary behaviours (24 interactions), resulted in three significant interaction effects. Thus in general, the intervention was equally effective in modifying dietary behaviours, regardless of socio-demographic or cognitive differences. However, we found that the effects of the intervention on intakes of sugar sweetened beverages and fruit were significantly moderated by level of education and awareness of personal intake levels,

respectively. The intervention significantly impacted sugar-sweetened beverages consumption among pre-university students, while effects on fruit intake were only observed among students who were aware of their low fruit intake levels at baseline. Furthermore, our results provide some indication that the home environment can moderate the intervention effect on dietary behaviours. We found that the effect of the intervention on vegetable intake was significantly moderated by perceived home availability. The effect on vegetable consumption was only found among students who reported that vegetables were always available at their home.

Interpretation of the findings

Computer tailoring is a health education technique specifically suited to make use of individual differences in socio-demographic, social cognitive and environmental correlates of intake levels, to personalize and individualize feedback and advice. We therefore hypothesized that the intervention effect would not be moderated by socio-demographic factors. In line with this hypothesis we indeed found no differences in effects according to gender and ethnicity, or according to education for three of the four dietary behaviours studied. These findings are largely in line with studies among adults, where no differential effects were found for educational levels on fat intake and physical activity [7,8]. A study among lower-income adults in the United States, however, found that the computer-tailored intervention was more effective in improving fruit and vegetables intake among lower educated compared to higher educated participants [9]. In contrast, our intervention was not effective in modifying sugar-sweetened beverages intake among the lower educated students, while it did among the higher educated. Possible reasons for this may be that the information was appreciated or comprehended less by the lower educated students. Results of the process evaluation of FATaint-PHAT (Chapter 8) indeed show that the information was better comprehended by the higher educated students as compared to the lower educated students, even thought lower educated students appreciated the intervention better, read it more carefully and more often discussed it with their parents. To our knowledge this is the first study that assessed differential effects of computer-tailored information according to ethnicity and the fact that we did not find differential effects is very promising for the implementation of computer-tailored interventions in ethnically diverse populations.

In the present study we found the anticipated moderation effect of awareness of low fruit intake. A possible explanation for why awareness only moderated fruit intake, but not the other behaviours, might be that the recommendation for fruit

intake in the Netherlands is clear and this recommendation has been communicated intensively, making the aware-students more responsive to take action. The suggestions for taking action and the action planning tool may also have helped these adolescents in actually improving their fruit intake. Unlike hypothesized students with a positive intention at the start of the study did not benefit more from the action planning part of the intervention compared to students with a neutral or negative intention to change behaviour. This suggests that the methods/strategy of the FATaintPHAT intervention to improve intentions might have been effective and both high and low intenders at baseline benefitted equally from the action planning part of the intervention. A tailoring study among adults showed the inverse of what we expected that highly motivated individuals were unresponsive to the intervention [8].

We expected that high availability of healthful and low availability of less healthful options would facilitate healthy behaviour change, since opportunity is an important determinant of dietary behaviour change [27]. Previous studies have shown that home availability of sugar-sweetened beverages is a predictor of sugar-sweetened beverage consumption [28], home availability of fruit and vegetables is correlated with fruit and vegetable consumption [13, 29], and home availability of unhealthy foods is a predictor of lower fruit and vegetable consumption [30]. Thus, as home availability of dietary products is associated with intake levels, it is likely that intervention effects depend on home availability levels as well. Furthermore, it is expected that it is easier for adolescents to translate this intention into action, when the environment is supportive as opposed to a situation where adolescents first have to overcome environmental barriers. We found that only for vegetable consumption perceived home availability appeared to be a prerequisite for an intervention effect. Vegetable intake in the Netherlands is very much dependent on family meals eaten at home. It is likely that for interventions to have an effect home availability is of less importance for foods that are less family meal dependent and often eaten outside the home environment. Another explanation may be that adolescents learned sufficient skills using the intervention to deal with environmental barriers for the other behaviours. Adolescent were for instance encouraged to discuss with parents to buy specific fruits, low calorie snacks or sugar-free drinks that they liked.

Study strengths and limitations

The strength of this study is that it is one of few to study moderation effects of computer-tailored interventions, adding to the understanding of the effectiveness

of computer tailoring among specific sub-groups. Moreover, as recommended we studied formal moderation effects by means of interaction analyses, as opposed to a priori stratified analyses, that should be avoided [1,2].

A limitation of this study is that it was not designed and thus underpowered for moderation and stratified analyses. Even though we used the recommended significance levels of $p < .1$ to test the significance of interaction term, significant interaction effects could have remained undetected. On the other hand, the fact that we tested for six moderators for four behaviours led to multiple testing, increasing the odds of finding statistically significant interactions that are in fact chance findings. The magnitude of the significant interaction effects is, however, quite large. So even if we would use a stricter significance level (i.e., $p< .01$) the interaction effects would still be significant. Furthermore, like in most studies on dietary change and its determinants, the dietary outcomes and the moderators were assessed with self-report measures which increases the likelihood of random measurement error. This might have weakened the effects found in this study.

Conclusions

The intervention was in general effective among all socio-demographic sub-groups and effective irrespective of prior awareness and intention levels. Nevertheless, the differential effects of educational level on sugar-sweetened beverage intake and of awareness on fruit intake need to be further explored. The significant moderation by home availability illustrates that the environment can influence effects of educational interventions and in future research this could be explored more often.

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Chapter 8

Process evaluation of FATaintPHAT, a computer-tailored intervention to prevent excessive weight gain among adolescents

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ABSTRACT

Background: Process evaluations can help to better interpret intervention effects and provide guidance in improving interventions. This study describes the use and appreciation of FATaintPHAT, a computer-tailored intervention to prevent excessive weight gain in adolescents and link these data to the intervention effects.
Methods: Use and appreciation were assessed among students (12-13 years) from the intervention group of the FATaintPHAT evaluation study, using computer-log (N=458) and questionnaire data (N=233, 48% response). Differences in use and appreciation between socio-demographic groups (gender, education, ethnicity, weight category), and associations of use and appreciation of the intervention with different dietary and physical activity behaviours were analyzed using descriptive and regression analyses.
Results: A majority of the students (81%) was exposed to all intervention modules and 73% reported to have put the advice into practice. Half and one third of the students appreciated the tailored advice positive or neutral, respectively. Students attending vocational training appreciated FATaintPHAT better than students attending university preparation education. No associations were found between appreciation and use of the intervention with changes in dietary and physical activity behaviours.
Conclusions: The school-based FATainPHAT intervention was used and appreciated well among adolescents. The fact that the intervention was appreciated better among the lower compared to higher educated students indicates that the technique of computer tailoring is also suitable for lower educated students.

BACKGROUND

Computer tailoring has shown to be a promising health communication technique to promote a healthy diet and probably also physical activity among adults [1-3]. Evidence for the efficacy and appreciation of the technique for promoting healthy dietary and physical activity behaviours among adolescents is scarce, since only few stand-alone computer-tailored interventions for adolescents have been developed and evaluated [4]. Computer tailoring is increasingly being used as a technique to match behaviour change information to the unique characteristics of a person [5]. Provision of personally relevant and individualized health education information is likely to be better appreciated and processed than generic information [5]. In this paper we will describe the use and appreciation of FATaintPHAT, a stand-alone computer-tailored intervention for adolescents that aims to prevent excessive weight gain by improving dietary, physical activity, and sedentary behaviours [6]. However, results of the effect evaluation study showed no effects for BMI, waist circumference or percentage overweight. Regarding the targeted behaviours, favourable effects were found for dietary intake (sugar-sweetened beverages, snacks, fruit and vegetables), but unfavourable effects for physical activity (sports and step count). No effects were found for whole wheat bread consumption (as a proxy for fibre intake), total physical activity, active commuting to school and sedentary behaviour (see Chapter 6).

Evaluating computer-tailored interventions among adolescents on process level factors such as use and appreciation is important to help interpret the intervention effects and guide improvement of interventions to increase intervention effectiveness [7]. In addition, research into the use and appreciation among specific socio-demographic subgroups can provide further insight in the usability of the technique of computer tailoring among such specific groups. This insight can inform specific targeting of interventions or inform further tailoring on socio-demographic characteristics.

Use and appreciation of an intervention are important process level factors to study, since these are prerequisites for active information processing which is necessary for achieving behaviour change [8, 9]. Information is more likely to be actively and thoughtfully processed when it is perceived as personally relevant [9-11]. Messages that are actively processed tend to be retained for a longer period of time and are more likely to lead to permanent attitude change [8]. Furthermore, the effectiveness of computer tailoring has been attributed to the fact that tailored feedback is processed more intensively, contains less redundant information, and is appreciated better than generic information [5]. Earlier research suggests that personal

relevance, individualization, and interestingness mediate intervention effects of a tailored nutrition intervention [12]. Given these potential working mechanisms, a higher use and appreciation are regarded as important and are possibly associated with favourable intervention effects. In more comprehensive school-based interventions which sometimes included computer tailoring, appreciation has been identified as a possible mediator or determinant of the intervention effects [13-15].

This study presents the results of the process evaluation of FATaintPHAT. The specific aims of this study were to assess:

1. Students' use (number of students who finished specific modules and the whole intervention, printed the tailored advice, discussed the advice with parents/peers, the extent to which the advice was read and put into practice) and appreciation (liking, personal relevance, usefulness, interestingness, comprehensibility of information, novelty of information, length, usability, and lay-out of the website) of FATaintPHAT;
2. Differences in use and appreciation according to socio-demographic factors (gender, education, ethnicity) and weight category;
3. Associations of use and appreciation with the targeted energy balance behaviours of FATaintPHAT at 4-months follow-up.

METHODS

Study design

This paper reports on the process evaluation conducted in the intervention group of the FATaintPHAT intervention evaluation trial conducted between 2006 and 2009. Details about the study design and the intervention are described elsewhere [6]. The cluster randomized trial and its procedures were approved by the Medical Ethics committee of the Erasmus MC.

Participants and recruitment

Students were recruited in a two-step procedure. First, an invitational letter or email was sent to 88 schools for secondary education in Rotterdam, the second largest city in the Netherlands, and surrounding municipalities. Twenty-three schools were willing to participate in the study. Schools were stratified according to educational level (vocational for students attending vocational training; pre-university for students who prepare for bachelor degree education) and randomly assigned

to either the intervention (11 schools) or control group (12 schools of which 3 schools dropped out after randomization, although allocation was concealed). In the second step, all students of up to five classes in the first year (12-13 years) were invited to participate. Students and parents were asked to provide informed consent. In total, 883 students participated; 485 in the intervention group.

The FATaintPHAT intervention

FATaintPHAT is an Internet-delivered intervention that was implemented by school teachers during 8 lessons of 15 minutes each, addressing the topic of weight management and energy balance and the following behaviours: consumption of sugar-sweetened beverages, snacks, fruit, vegetable and fibre, physical activity, and sedentary behaviours (television and computer use) in separate modules. Each intervention module consisted of a brief introduction to the topic with information about the behaviour-health link, an assessment of behaviour and determinants, individually-tailored feedback and an option to formulate an implementation intention to prompt specific goal setting and action planning. The feedback could be printed and included several elements: behavioural feedback, comparing the student's behaviour with guidelines for that behaviour (normative feedback), and with behaviour of peers (comparative feedback), prompts for intention formation, decisional balance information to change attitudes, prompts for barrier identification and instructions on how to perform/change a behaviour to improve self-efficacy, and suggestions on how to organize social support. A multi-theoretical approach, integrating insights from the Theory of Planned Behaviour [16], the Precaution Adoption Process Model [17] and implementation intentions [18] was used to inform the intervention. The intervention was implemented by school teachers (n = 19). Teachers received a teacher manual including instructions on the implementation schedule, on the content and procedure of working with the website itself, and on troubleshooting. The advice could be printed during the school lesson.

Measurements

Use of the intervention, operationalized as the number of students who completed all intervention modules [19], and completion of each intervention module was measured objectively, based on computer log data. The process evaluation questionnaire was administered directly after the final module of the intervention which was on fibre consumption. Completion took five to ten minutes and was supervised by a teacher. The process evaluation questionnaire consisted of 24 items. Different aspects of use of the tailored feedback were assessed with 6 items:

'Did you print your advice?' (no – yes, advice regarding a few modules - yes, everything), 'Did you discuss your personalized advice with your parents?' (no – yes, a few modules - yes, everything), 'Did you discuss your personalized advice with peers?' (no – yes, a few modules - yes, everything), and 'How well did you read the advice?' (very poor (-2) – very well (+2)). Participants were also asked whether they followed the suggestions given in the advice 'Did you put the advice into practice?' (no – to some extent – yes).

Various dimensions of appreciation of the content of the tailored advices were assessed with the following items, measured on a 5-point scale ranging from -2 to +2: liking ('What did you think of the advice given?', did not like it at all - liked it very much), personal relevance ('Did you think the advice given was specially meant for you', absolutely not – absolutely yes), and usefulness of the information ('Did the advice contain a lot of useful information?', absolutely not – absolutely yes). These questions were asked for each module (sugar-sweetened beverages, sedentary behaviour, snacks, fruit, physical activity, vegetables, fibre, and weight management/energy balance). An overall score for liking, personal relevance and usefulness of information was computed as an average of the ratings for all modules. Cronbach's alpha's were 0.91 for the liking and personal relevance scores and 0.92 for the usefulness of information scores. In addition, more general aspects of the FATaintPHAT intervention and its content were evaluated by means of the following items: interestingness ('Did you find the information interesting?'; not interesting – very interesting), comprehensibility ('Did you think the information was easy or difficult to understand?'; very difficult – very easy), and novelty of information, measured on a 3-point scale ('Did you learn new thing in FATaintPHAT?'; no – some – yes, a lot). General questions about the appreciation of FATaintPHAT were assessed on a 5-point scale (ranging from -2 to +2): length ('What do you think of the length of the modules?'; too short – too long), usability of the website ('Did you think the website was easy to use?'; very difficult to use – very easy), and lay-out of the website ('How did you think the website looked?'; very bad – very good). Finally, an overall rating was asked ('What grade would you give FATaintPHAT?' (1 lowest grade – 10 highest grade). Questions were based on previous research on appreciation of computer-tailored interventions [20-23]. The data of the 3-point scales were dichotomised distinguishing no and all other answer categories ('yes everything/yes, partially = yes; no = no) for use as dependent variables in the regression analyses.

The energy balance-related behaviours (i.e. dietary, physical activity and sedentary behaviours) that were addresses by the intervention were assessed with a

computer questionnaire [6] at baseline and 4 months follow-up. Questionnaires were completed under the supervision of a researcher during a class hour. Dietary intake was assessed using a food frequency questionnaire assessing the frequency and quantity of consumption of sugar-sweetened beverages, fruit and vegetables and whole wheat bread, and a self-administered 24-hour recall for snacks. Physical activity and sedentary behaviours were assessed using a questionnaire which assessed sports during leisure time, active transportation to school, television viewing, and computer use during leisure time in the past seven days by asking about the frequency and duration of the activities. In addition, the number of days the student was physically active for at least 60 minutes was assessed. Adapted versions of validated questionnaires were used for snack [24] and fruit and vegetables intake [25, 26]. Physical activity and sedentary behaviours were assessed using an adapted version of the Flemish validated questionnaire [27].

Questions on demographics included gender, age, educational level (vocational vs. pre-university) and ethnicity. Ethnicity was defined according to Statistics Netherlands as either Western (both parents born in Europe, North-America, Oceania, Indonesia or Japan) or non-Western (at least one parent born elsewhere). Height was measured without shoes using a Seca 225 mobile height rod with an accuracy of 0.1 cm. A calibrated electronic digital floor scale (SECA 888 class III) was used to measure the body weight with an accuracy of 0.2 kilogram. BMI was calculated as weight (kilograms) divided by height (meters) squared. Weight category was based on the IOTF cut-off points [28].

Analyses

Descriptive statistics were used to describe the study sample, as well as use and appreciation of the intervention (use, liking, personal relevance, usefulness, interestingness, comprehensibility, novelty of information, length, usability, lay-out, printed advice, discussed with parents/peers, how well advice was read, and put advice into practice).

Multilevel multiple linear and logistic regression analyses were conducted to test differences in the use and the appreciation variables (as dependent variables), according to socio-demographic factors: education (pre-university (1) vs. vocational (0)), gender (girls (1) vs. boys (0), ethnicity (non-Western (1) vs. Western (0), and weight category (overweight (1) vs. normal weight (0)) (independent variables). The data of the 5-point scales were checked for normality before inclusion as dependent variable in the regression models.

In addition, multilevel multiple linear and logistic regression analyses were conducted to assess whether use and a selection of appreciation variables (liking, personal relevance, usefulness, interestingness, put advice into practice, and novelty of information; as independent variables) were associated with changes in energy balance-related behaviours (consumption of sugar-sweetened beverages, snacks, fruit, vegetables, and whole wheat bread, physical activity and sedentary behaviours), as indicated by differences in behaviours at 4 months follow-up adjusted for baseline levels. Analyses were adjusted for: education, gender, ethnicity, and weight category. The independent variables were checked for multicollinearity (i.e. $r \geq 0.9$).

For all analyses a significance level of 0.05 was used. Multilevel regression accounts for the clustered variances between schools. Analyses were performed using SPSS version 17.0 and MLwiN 2.02 (multilevel analyses).

RESULTS

Students' characteristics

In Table 1 the student characteristics are presented for the 233 students who completed the process evaluation questionnaire (response of 48%). About 45% of our sample was girls, mean age was 12.7 year, 36% was from non-Western ethnicity and 66% attended vocational training.

Table 1 Descriptive characteristics of the total study sample (n=233)

	Total sample
Gender (%)	
Boys	54.9
Girls	45.1
Age in years	
Mean age (SD)	12.7 (0.6)
Weight Category (%)	
Underweight	7.6
Normal weight	72.5
Overweight	14.7
Obese	5.2
Ethnic Background (%)	
Western	63.5
Non-Western	36.5
Education	
Vocational	66.4%
Pre-university	33.6%

Students' use of FATaintPHAT

The intervention was completed by 81% of the students. The subsequent intervention modules were completed by the following percentage of students: energy balance: 97%; sugar sweetened beverages: 97%; sedentary behaviour: 96%; snacks: 94%; fruit: 92%; physical activity: 87%; vegetables: 86%; and fibre: 81%. Table 2 shows that of the students who completed the process evaluation questionnaire, one third reported to have printed the advice, 73% reported to have followed the suggestions given in the advice, 40% discussed part or all of the content with a parent, and also 40% discussed it with peers. In addition, two thirds of the students reported to have read the advice well or very well and a quarter reported to have read it neither good nor bad.

Students' appreciation of FATaintPHAT

The results regarding the appreciation variables are shown in Table 2. Around half of the students liked the tailored advice, thought it was personally relevant, found the information useful and interesting and thought it was easy to comprehend, while one third was neutral (not positive/not negative) about the intervention they received. A large majority (83%) of the students indicated that they had learned

Table 2 Descriptive statistics regarding students' appreciation of the intervention program and its contents (n=233)

	Mean (SD)	Answer categories (%)				
		-2	-1	0	1	2
Appreciation content tailored advice						
Liking (not at all (-2) – very (+2))	0.51 (0.77)	3.9	2.5	40.8	42.5	10.3
Personal relevance (not at all (-2) – very (+2))	0.35 (0.83)	3.4	9.9	43.8	33.0	9.9
Useful information (not at all (-2) – very (+2))	0.56 (0.83)	3.9	2.5	39.1	40.3	14.2
Interestingness (not at all (-2) – very (+2))	0.38 (1.08)	7.7	8.2	37.8	31.3	15.0
Comprehensibility (very difficult (-2) – very easy (+2))	0.67 (1.08)	5.2	5.2	33.0	30.5	26.2
Novelty of information (no, some, yes)	0.08 (0.65)		17.2	57.5	25.3	
Appreciation FATaintPHAT programme						
Length (too short (-2) – too long (+2))	0.76 (0.98)	2.1	4.3	36.9	29.2	27.5
Usability (very difficult (-2) - very easy (+2))	1.01 (0.89)	1.3	3.0	21.9	41.2	32.6
Lay-out (very bad (-2) - very good (+2))	0.59 (1.02)	5.6	5.2	31.8	39.5	18.0
Use Tailored Advice						
Printed advice (no, few modules, everything)	-0.45 (0.79)		63.9	17.2	18.9	
Discussed with parents (no, partly, everything)	-0.42 (0.76)		59.2	24.0	16.7	
Discussed with peers (no, partly, everything)	-0.46 (0.71)		58.4	29.2	12.4	
How well read advice (very badly (-2) – very well (+2))	0.66 (1.10)	8.2	2.6	27.0	39.9	22.3
Put advice into practise (no, some, yes)	-0.06 (0.69)		27.0	51.9	21.0	

SD: standard deviation

some or many new things from the intervention. More than half (56%) rated the advices as too long and 37% rated the length as fine (not too long/not too short). The lay-out was well appreciated by 58% of the students. The average grade on a scale from 1-10 the students assigned FATaintPHAT was 7.1.

Differences in use and appreciation by socio-demographic factors

In general, students in vocational training appreciated the intervention better (liked the feedback better, found it more useful and interesting and reported they learned more new things) than pre-university students (Table 3). Moreover, they reported more often to have discussed the information with their parents and have read it better compared to pre-university students. Pre-university students perceived it as longer and reported to better comprehend the information.

Differences in appreciation according to gender, ethnicity and weight category were less pronounced. Girls more often reported to have learned new things and they read the advice better compared to boys. Students of non-Western ethnicity reported to comprehend the information better than other students. Students who were overweight found the information more useful than normal weight students.

Association of use and appreciation with behavioural outcomes

We did not find significant associations of any of the process measures (use, liking, personal relevance, usefulness, interestingness, put advice into practice, and novelty of information) with behaviour changes (i.e. posttest behaviour scores adjusted for baseline levels).

DISCUSSION

Main Results

Large majorities of the students were exposed to all the modules of the intervention and reported to have put the advice into practice. In general, about half of the students reported to have appreciated the tailored advice, and less than one-fifth reported negative appreciation. Vocational students appreciated FATaintPHAT better than the pre-university students. No associations were found between use and appreciation scores and changes in energy balance-related behaviours.

Table 3 Results of multiple regression analyses with the process measures as dependent and socio-demographic factors as independent variables (n=233)

		Educational level (Vocational=0; Pre-university=1)	Gender (Boy=0; Girl=1)	Ethnicity (Western=0; non-Western=1)	Weight category (normal=0; overweight=1)
Appreciation content tailored advice					
Liking (not at all (-2) – very (+2))	b	**-0.42** (-0.66; -0.19)	0.06 (-0.16; 0.27)	0.09 (-0.14; 0.32)	0.14 (-0.12; 0.41)
Personal relevance (not at all (-2) – very (+2))	b	-0.22 (0.48; 0.04)	0.08 (-0.16; 0.31)	-0.01 (-0.27; 0.25)	0.27 (-0.02; 0.57)
Useful information (not at all (-2) – very (+2))	b	**-0.32** (-0.59;-0.05)	0.02 (-0.20;0.25)	0.11 (-0.14;0.36)	**0.30** (0.02;0.059)
Interestingness (not at all (-2) – very (+2))	b	**-0.54** (-0.87; -0.22)	0.17 (-0.12; 0.46)	-0.02 (-0.34; 0.30)	0.13 (-0.23; 0.50)
Comprehensibility (very difficult (-2) – very easy (+2))	b	**0.55** (0.18; 0.92)	-0.03 (-0.32;0.26)	**0.36** (0.03; 0.68)	0.15 (-0.21; 0.51)
Novelty of information (0 no; 1 yes)	OR	**0.29** (0.13; 0.66)	**2.72** (1.21; 6.12)	0.82 (0.35; 1.92)	0.70 (0.28; 1.77)
Appreciation FATaintPHAT					
Length (too short (-2) – too long (+2))	b	**0.42** (0.14; 0.71)	-0.24 (-0.50; 0.02)	0.04 (-0.24;0.32)	-0.18 (-0.50; 0.14)
Usability (very difficult (-2) - very easy (+2))	b	-0.06 (-0.33; 0.22)	-0.10 (-0.34; 0.15)	0.20 (-0.07; 0.47)	-0.03 (-0.34; 0.28)
Lay-out (very bad (-2) - very good (+2))	b	-0.17 (-0.49; 0.15)	-0.02 (-0.30; 0.27)	-0.04 (-0.35; 0.27)	0.05 (-0.30; 0.41)
Use program and tailored advice					
Printing advice (0 no; 1 yes)**					
Discussed with parents (0 no; 1 yes)	OR	**0.37** (0.19; 0.73)	1.47 (0.82; 2.62)	0.57 (0.30; 1.08)	1.58 (0.77; 3.21)
Discussed with peers (0 no; 1 yes)	OR	1.08 (0.58; 2.02)	0.93 (0.53; 1.64)	0.60 (0.32; 1.13)	0.59 (0.28; 1.23)
How well read advice (very badly (-2) – very well (+2))	b	**-0.41** (-0.75; -0.07)	**0.36** (0.05; 0.66)	-0.04 (-0.38; 0.30)	0.04 (-0.34; 0.43)
Put advice into practice (0 no; 1 yes)	OR	1.05 (0.52; 2.11)	1.18 (0.63; 2.22)	0.72 (0.37; 1.42)	1.23 (0.55; 2.75)
Reach (completed program: 0 no; 1 yes)	OR	1.54 (0.29; 8.32)	1.24 (0.66; 2.31)	0.63 (0.33; 1.20)	0.65 (0.31; 1.39)

b: unstandardized regression coefficients; OR: odds ratio; 95% confidence Intervals between brackets; SSB: sugar-sweetened beverages; ** Model does not converge

Interpretation

Computer tailoring is a promising health communication technique to change dietary and possibly also physical activity behaviours in adults [1-3, 29, 30]. FATaintPHAT is one of the first studies evaluating a stand-alone computer-tailored programme for adolescents. This study can therefore extend our knowledge about the usability and possible working mechanism of computer tailoring for adolescents. FataintPHAT was effective in initiating changes in sugar-sweetened beverages, snacks and vegetable consumption (see Chapter 6). Computer-tailored information is thought to be more personally relevant, useful, interesting and new than generic information [8]. The students who used FATaintPHAT did indeed like the information, thought the tailored advices were relevant for them, were useful, interesting and new. Therefore, the supposed working-mechanisms that add to the effectiveness of computer tailoring might be relevant for adolescents as well. Our results show that about 40% of the students discussed their advice with their parents and also 40% discussed it with peers. This may be an indication that students to some extent process the information actively which is necessary for behaviour change [8, 9].

Moreover, about three quarters of the students reported to have put their advice into practice. A study of Haerens et al. [4] on a 1-hour computer-tailored physical activity intervention for adolescents showed that only about one third was planning to put the advice into practice. These differences in using the suggestions provided in the advice might be explained by the fact that FATaintPHAT offers a choice on a variety of behaviours to change (dietary, physical activity and sedentary behaviours), while the intervention of Haerens et al. [4] only focussed on physical activity. Furthermore, the appreciation of FATaintPHAT as a whole was comparable with the results of the physical activity computer-tailored intervention of Haerens et al. [4], who found that about half of the students thought the tailored advice was interesting and about 40% perceived it as being personally relevant, credible and easy to use. The physical activity advice of Haerens et al. was perceived as too long by 50% of the students.

In general, lower educated people have less healthful lifestyles [31, 32] compared to higher educated people. This was also the case among the students in our sample (unpublished data). Therefore, it is of specific importance that vocational students will use and appreciate an intervention aimed at improving their health behaviour. FATaintPHAT was completed equally well by higher and lower educated students. Previous studies have shown that respondents with a lower educational

level were more appreciative of tailored health information than general health information [23, 33]. Accordingly, in our study the vocational students liked the modules better than the pre-university students and thought it was more useful. At the same time, the pre-university students perceived the advices as easier than the vocational students. An explanation for these findings might be that the information was already familiar to the pre-university students. This explanation is supported by our results on the novelty and interestingness of the information, where the vocational students reported to have learned more new things and found the information more interesting compared to the pre-university students. These results suggest that in general computer tailoring has the potential to be an appreciated strategy by lower educated students and that the FATaintPHAT intervention is applicable among both higher and lower educated students.

We did not find associations for use and appreciation of the intervention with changes in energy balance-related behaviours after exposure to the intervention. We were not able to conduct a true mediation analysis to explore this association because the control group in the FATaintPHAT study did not provide data about the appreciation of the regular curriculum. Of the studies in which an association was found between appreciation variables and intervention effects [12-14] most studies used a stronger design [12, 13]. In addition, these studies were different from FATaindPHAT with respect to their goal and target population. Tak et al. [13] focussed on increasing availability of fruit and vegetables at primary schools and Wind et al. [14] used a multi-component intervention at primary schools to increase fruit and vegetable consumption including an availability component, computer-tailored education and involvement of parents. The intervention of Oenema et al. [12] targeted self-selected adults who used the Internet-based intervention at home. Therefore, the differences between the results of these studies and our study could possibly be explained by differential effects of environmental intervention versus more cognitive interventions or by differences in baseline motivation of the respondents. If we compare the process outcomes with the effect outcomes (see Chapter 6) we can conclude that the favourable effects on dietary behaviours are supported by the positive rating and use of FATaintPHAT. However the unfavourable and absent effects for physical activity and sedentary behaviour cannot be explained by the appreciation and use of the intervention.

Strengths and Limitations

The strength of this study is the use of an innovative intervention strategy (computer tailoring) among adolescents and the use of computer-log data to assess use.

A limitation of the study is a possible selective sample of those who completed the process evaluation questionnaire, since only 48% of the intervention users completed the questionnaire. This limits the generalizability of the findings to other samples. If students with a low appreciation of the intervention did not complete the process evaluation questionnaire, our results may be an overestimation of true appreciation. However, we found that overweight adolescents more often completed the process evaluation, while no significant differences were found for gender, educational level or ethnicity. Since being overweight was not significantly related to appreciation of the intervention it is not likely that this selected sample leads to biased results. A second limitation is the absence of a generic information control group process outcomes, so results cannot explain specific characteristics of a computer-tailored versus a generic intervention.

Conclusion

The computer-tailored intervention FATaintPHAT was used and appreciated well among adolescents from higher and lower educational levels, but somewhat better among the lower educated. The findings of this study add to the evidence indicating that computer tailoring can be used among adolescents in school settings.

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Part 4

Discussion

Chapter 9

General discussion

To prevent illness and loss of quality of life due to overweight and obesity, a planned development of interventions with specific underpinning of each step (identification of related behaviours, related determinants, and systematic intervention development) is needed. This thesis adds to the evidence on risk factors and determinants of excessive weight gain among adolescents and presents the systematic development and evaluation of FATaintPHAT, an intervention aiming to contribute to the prevention of excessive weight gain by improving energy balance-related behaviours. The larger aims of this thesis are to:

- Contribute to the understanding of specific dietary, physical activity and sedentary behaviours that are related to the energy balance and the personal and environmental predictors among adolescents (Part 1).
- Evaluate the main and differential effects, use, and appreciation of FATaint-PHAT, a computer-tailored health education program aimed to contribute to the prevention of excessive weight gain among adolescents (Part 2).

In this general discussion chapter the main findings of the studies are summarized and discussed in a broader context, methodological considerations are discussed, and implications for research and practice are presented.

1 MAIN FINDINGS

1.1 Part 1 Risk factors and determinants

In part 1 of this thesis three studies were performed, one on the psychosocial and demographic predictors of the intention to prevent excessive weight gain (chapter 2), one on behaviours that have been found to be related to obesity trends in earlier studies (chapter 3), and one on the personal and environmental predictors of sugar-sweetened beverage consumption (chapter 4). The results showed that a majority of the adolescents aged 12 to 13 years that participated in the study had a positive intention to prevent excessive weight gain, but that they did not feel at risk of excessive weight gain. Moreover, this positive intention was predicted by a positive attitude (considering the prevention of excessive weight gain as good and important) and high internal control (the belief that prevention of excessive weight gain is under their own control). The study on behaviours related to obesity suggested a possible protective role for sports team participation, limited television viewing, a regular meal pattern and consumption of milk products and cereal. The third study showed that almost half of the adolescents engaged in one of the risk behaviours that have shown to be related to excessive weight gain, i.e. consump-

tion of more than two glasses of sugar-sweetened beverages per day. Perceived behavioural control for reducing sugar-sweetened beverage intake was related with lower intake and high home availability and less strict family rules with higher intake four months later. Mediation analyses to understand the relation between environmental factors and intake showed that a lower home availability was associated with higher perceived behavioural control and this was associated with a decrease in consumption.

1.2 Part 2 Development and evaluation of FATaintPHAT

In chapters 5 to 8 the steps in the planned development of the FATaintPHAT intervention, the protocol for the effect and process evaluation and the results of these evaluations are presented. To contribute to curbing the overweight and obesity trends in the Netherlands FATaintPHAT was developed based on the existing evidence on specific dietary, physical activity and sedentary behaviours related to overweight and obesity (energy balance-related behaviours) and determinants of these behaviours. The intervention aimed to prevent excessive weight gain by improving the following behaviours: consumption of sugar-sweetened beverages, snacks, fruit, vegetables and fibre, active transport, sports, television viewing and computer use. Computer tailoring was used as the main educational technique and the intervention was based on the Precaution Adoption Process Model, the Theory of Planned Behaviour and action planning. The effects of FATaintPHAT were measured on anthropometry (after two years) and on energy balance-related behaviours (after four months and two years). Furthermore, to understand for whom and in what circumstances FATaintPHAT was effective moderation analyses were performed to assess if the short-term effects on the dietary behaviours differed according to socio-demographic (gender, education level, ethnicity), personal (awareness, intention) and environmental (home availability) factors. In addition, process level outcomes, such as use and appreciation were evaluated to be able to better interpret the intervention effects and provide guidance in improving the intervention.

The results regarding the effectiveness indicate that FATaintPHAT had no effects on anthropometric outcomes at 2-years follow-up. Favourable effects were found on self-reported dietary behaviours at 4-months follow-up (consumption of sugar-sweetened beverages, snacks, and vegetables), but not at 2-years follow-up. Unexpected negative effects were found for total step count at four-months follow-up. No effects were found for sedentary behaviours and the self-reported physical activity behaviours. Among students who were not acting according to recom-

mended intake or activity levels and therefore would have received an advice to improve their behaviours, there was in addition an effect on fruit consumption, but not for sugar-sweetened beverages intake, and some unfavourable effects for physical activity behaviours (sports participation and step counts) at 4-months follow-up were found. As hypothesised most dietary intervention effects were not moderated by socio-demographic factors indicating that the intervention was equally effective for the higher and lower educated students. An exception was the effect for sugar-sweetened beverage consumption; the effect was only observed among students attending pre-university level education. Moreover, students who at baseline were aware of their low fruit intake increased their consumption while students who were not aware of their low intake did not. This moderation effect was not observed for the other dietary behaviours. Furthermore, the intervention effects were not moderated by intention either. A high home availability appeared to be a prerequisite for an intervention effect for vegetable intake, but not for the other behaviours. The process evaluation showed that 81% of the students had been exposed to all intervention modules and 73% reported to have put the advice into practice. Half of the students reported to appreciate the tailored advice positively, while one third was neutral. Vocational training students appreciated the intervention somewhat better compared to students attending pre-university education. We did not find associations between appreciation and use and changes in behaviour.

2 REFLECTION ON STUDY FINDINGS

2.1 Part 1 Risk factors and determinants

2.1.1 Psychosocial and demographic predictors of the intention of weight gain prevention

Preventing excessive weight gain among adolescents is important to control the obesity epidemic [1]. Currently, much research for obesity prevention is focused on behavioural factors related to the prevention of excessive weight gain among adolescents [2-5], omitting a focus on the higher level goal of prevention of excessive weight gain. The intention to prevent excessive weight gain may be an important driver for intention and enactment of changes in relevant weight related behaviours and is therefore a potentially important determinant to target in interventions aimed at the prevention of excessive weight gain [6]. To be able to modify the intention to prevent excessive weight gain, it is important to have insight in

the underlying factors, which are currently unknown. Therefore, in chapter 2 the potential psychosocial and demographic predictors of the intention of adolescents to prevent excessive weight gain were examined. We found that 68% of the students had a positive intention to prevent excessive weight gain, but that only 14% perceived themselves as being at risk. Research has shown that adults have a high intention to prevent weight gain as well (mean 1.36 on a scale from -2 to +2) [7], while risk to gain weight was perceived somewhat higher by adults (5.92 on a scale from 1 to 15, measured as perceived threat x perceived seriousness) [7]. Furthermore, we found that an increase in intention to prevent excessive weight gain over a four-month period was predicted by an increase in positive attitudes and perceived internal control and a higher perceived weight by adolescents. Among adults intention for weight gain prevention was associated with attitudes and risk perception [7]. However, the results presented in this thesis show that adolescents seem not very aware of their risk of excessive weight gain and therefore this might explain that no changes in intention to prevent excessive weight gain among adolescents were found. In the literature, it has been shown that adolescents are often aware of health risks, but might not perceive these risks as personally relevant [8, 9]. Our results suggest that attempts to promote positive intentions to prevent excessive weight gain among adolescent may focus on promoting positive attitudes and development of a stronger (sense of) internal control. Therefore, interventions to prevent excessive weight gain might want to improve adolescents' sense that the prevention of excessive weight gain is something good and important and provide support to help adolescents to control their dietary, physical activity and sedentary behaviours (to improve the internal control). Associations between an increased intention to prevent excessive weight gain and possible related behaviours is a next important topic for study.

2.1.2 Behavioural risk factors for the prevention of excessive weight gain

More insight in which behaviours are important drivers of the overweight and obesity pandemic is necessary. To contribute to further insights in potential risk and protective behaviours secondary data analyses on a surveillance study in Texas, USA were conducted. Surveillance of obesity provides an important opportunity to assess changes over time while also comparing regions to better understand etiologic mechanisms of obesity and potential protective factors that may inhibit the increase in obesity. The School Physical Activity and Nutrition (SPAN) study is a population-based surveillance system that measures the prevalence of obesity and energy balance-related behaviours in Texan school children by region [10]. An exploration of obesity trends over the period 2000/2002 to 2004/2005 showed

that the prevalence of obesity in 4th grade (9-10 year old) students living in the El Paso region, decreased by 7 percentage points (25.8% to 18.8%), while in a demographically and geographically comparable region, Rio Grande Valley region, prevalence increased from 25.8% to 30.6% [11]. In chapter 3 we assessed whether changes in energy balance-related behaviours might explain the differences in obesity trends between these regions. We found that students in the El Paso region experienced a lower decrease in sports team participation, an increase in regular meal consumption, and an increase in the frequency of milk/yoghurt, cereal, sweet snacks and frozen dessert consumption between measurement periods compared to students in the Rio Grande Valley region. Prevalence of frequent television viewing was lower in the El Paso region. The lower BMI in the El Paso region was associated with regular meal consumption, higher milk/yoghurt and higher sweet snacks consumption in a mediation analyses. These results suggest a protective role for sports team participation, limited television viewing, regular meal patterns, consumption of milk products and cereal. Reviews on the relation between behaviours and obesity confirm the probable importance of television viewing [4, 12-14], sports team participation [15], and cereal consumption [5]. There is mixed evidence for dairy consumption as a possible protective factor [5, 16-19], and evidence for the number of meals per day is unclear due to differences in definitions of meals/eating moments and inverse causality. One finding that is difficult to interpret was the reported decrease in sweet snack and frozen dessert consumption in the Rio Grande Valley region and increase in sweet snack and frozen dessert consumption in the El Paso region. One explanation for this unexpected result could be that people with obesity tend to underreport consumption of foods, especially snack food [4, 20]. It is possible that students in the Rio Grande Valley region, which has a higher prevalence of obesity, may underreport sweet snack and frozen dessert consumption. Another explanation might be that we assessed the number of times a student ate snacks or frozen dessert, but not the amount eaten. It may be that consumption frequency does not reflect total consumption well-enough. In conclusion, the results suggest that the following behaviours most likely contribute to the prevention of excessive weight gain in children: sports team participation, limiting television viewing and cereal consumption. The results of the SPAN study indicate a protective role for regular meal patterns and the consumption of milk products, however, supporting evidence for these behaviours is still limited and more research is needed.

2.1.3 Personal and environmental predictors of risk behaviours

Although the SPAN study did not provide indications that sugar-sweetened beverage consumption was associated with an increased risk for excessive weight gain, recent reviews have indicated that high intakes of such beverages are associated with higher risk for weight gain, overweight and obesity [5, 15, 16, 21-24]. In the introductory chapter it was argued that to be able to change a behaviour, the personal and environmental determinants or mediators need to be addressed [25]. In chapter 4 we studied personal cognitive factors as well as family food rules and perceived home availability of sugar-sweetened beverages as potential predictors of change in sugar-sweetened beverages consumption in a longitudinal study. Results of this study showed that adolescents with a high perceived behavioural control and more positive attitudes to decrease sugar-sweetened beverages intake were more likely to decrease their intake. In addition, adolescents reporting high availability of sugar-sweetened beverages at home and a family food rule that allowed them to (almost) always drink as much sugar sweetened beverages as they liked, were more likely to increase their intake as compared to students with low availability and a strict rule. The association between availability and decrease in sugar-sweetened beverage consumption was almost completely mediated by perceived behavioural control. The results of this study add to the evidence on the importance of environmental factors besides personal factors in the prediction of behaviour and behaviour change, a relation that is proposed in the EnRG model [25]. Even though various studies have shown the importance of the home environment for child and adolescent sugar-sweetened beverages consumption (for boys) [26, 27] and other behaviours [26-28], our study is among the first that support the hypothesized mediation of personal factors in the relation between environmental factors and behaviour [25]. Such mediation is also described for liking and self-efficacy in the relation between home availability and fruit consumption among 11-year olds [29] and for intention, attitudes and habit strength in the relations between a television in the bedroom, parental modelling, and family rules and self-reported television viewing among adolescents [30].

2.2 Part 2 Development and evaluation of FATaintPHAT

The following paragraph will reflect on the study findings on the effectiveness of FATaintPHAT in general and in subsequent paragraphs a number of specific topics related to the intervention and the evaluation will be discussed: the role of the environment in intervention effectiveness, the use of computer tailoring for adolescents and differences in appreciation and use according to educational level.

2.2.1 Effectiveness of (computer-tailored) interventions for weight gain prevention

The FATaintPHAT study is one of the first computer-tailored interventions to address seven energy balance-related behaviours (consumption of sugar-sweetened beverages, snacks, fruit, vegetables, and fibre, physical activity and sedentary behaviour) and one of the first to evaluate a stand-alone computer-tailored intervention for adolescents. The FATaintPHAT intervention did not result in any differences in anthropometric outcomes between the intervention group and control group at two year follow-up. No and even some negative effects were found for physical activity and sedentary behaviours at four months and two years follow-up, while positive effects on dietary behaviours were found, but only at four months follow-up. Even though these results run in part contrary to what was intended, the findings are in line with recent reviews that have found that school-based interventions (educational and/or environmental) had very little effect on anthropometrics, limited effect on physical activity and some effects on dietary behaviours [31-34].

The fact that no significant intervention effects were found on anthropometric outcomes at the second follow-up indicate that the behaviour changes induced by the intervention were not strong enough and not sustained long enough to influence weight. Recent evidence suggests that interventions with a longer duration and interventions that combine educational and environmental intervention components may be required to produce effects on anthropometric outcomes [32 35]. FATaintPHAT did not modify the physical environment (by increasing the number of physical education classes or making the school canteen healthier). FATaintPHAT did include elements that were aimed at creating a more positive home environment by providing suggestions to the students, for example to ask their parents to buy healthy alternatives for unhealthy snacks or their favourite vegetables. We do not know, however, whether this resulted in significant changes in the home environment. Another possible explanation for not finding effects on anthropometric outcomes might be that students have substituted behaviours, e.g. decreasing energy intake, while at the same time decreasing physical activity.

It is promising that FATaintPHAT showed indications of positive effects on dietary behaviours. The intervention was associated with a lower odds (0.54) of drinking more than 400ml of sugar-sweetened beverages per day, lower snack intake (b= -0.81 snacks/day), and higher vegetable intake (b= 19.3 grams/day) at 4-months follow-up. In addition, among students at risk, FATaintPHAT had a positive effect

on fruit consumption (b=0.39 grams/day) at 4-months follow-up. Given that the intervention was of relatively low intensity (only two hours in total) these findings compare positively with the effects that have been found in previous school-based studies, both in terms of number of effects and the sizes of the effects. Haerens et al. [36, 37] found an effect on fat intake, at one and two years follow-up, but not on sugar-sweetened beverages, fruit and water consumption. Singh et al. [38] did not find effects on snack consumption, but they did find an effect on sugar-sweetened beverages consumption after 8 and 12 months of about 250 ml difference between groups; they did not find an effect after 20 months. Martens et al. [39] did not find a significant effect for fruit intake or on breakfast consumption, but they did find an effect on snack consumption (0.6 pieces) at 3 months post baseline. Knai et al. [40] found in their review on fruit and vegetable consumption that of the four identified interventions, two did not find significant effects after three years, one found an effect of 0.3 servings per day among girls after two years, and one study found an increase of 0.9 servings per day at interim evaluation but no effect at 2-year follow-up. Muth et al. [41] found an increase of 0.9 servings of fruit and vegetables per day directly after the intervention period. It is noteworthy that these other interventions were all high intensity programs that comprised of more components than only tailored feedback. More in general, these studies illustrate that school-based interventions have the ability to improve dietary behaviours among children and adolescents [32, 42]. Given the positive effects and the reasonable effect sizes on most dietary behaviours FATaintPHAT could be implemented in schools as an intervention to promote health dietary behaviours.

Possible explanations for the lack of or unfavourable effects on physical activity, sedentary behaviour and whole wheat bread consumption and for finding no sustained effects on dietary behaviours may be found in 1. the content of the intervention modules and 2. the intensity of the intervention (multiple sessions, but single exposure to one module). First, the content of the physical activity, sedentary behaviours and fibre consumption modules (behavioural feedback, arguments) might have been perceived as unconvincing by the adolescents. In addition, FATaintPHAT contained five modules for the five dietary behaviours targeted, while it contained only one module for the physical activity behaviours (sports, active commuting, and activity during leisure time). This might have led to insufficient feedback on the specific physical activity sub-behaviours to have an effect. Moreover, lack of effects might be related to information processing and this will be further discussed in a next paragraph. Second, it might be that the intervention was not strong enough to have sustained effects, possibly due to its short duration (8 sessions of 15 minutes within 10 weeks). A recent review [35] showed that dy-

namically tailored interventions (i.e. iterative assessments and feedback) showed larger effect sizes then statically tailored interventions, and these effects were also maintained over a longer follow-up period. This larger effect size for dynamically tailored interventions could be explained by more frequent overall contacts that dynamic tailoring necessitates. Moreover, it appears that more than just providing additional contact with dynamic tailoring, updating feedback to reflect a person's changes may increase information relevance and depth of processing [35]. However, given the education-only approach and the limited intensity of FATaintPHAT effect sizes for the dietary behaviours were quite large and may be increased by adding environmental or repetitive elements. Even though the null or negative effects for the physical activity behaviours are a concern and an indication that the intervention needs to be improved for these behaviours, the findings of the study are in line with the physical activity intervention literature in which null or mixed results are common [33, 34]. Furthermore, it was found that physical activity interventions may be more successful in primary school children and among girls [34]. Among adults it has been found that a larger proportion of computer-tailored dietary interventions resulted in changes in behaviour than computer-tailored physical activity interventions [35, 43-46]. Moreover, it has been reported that changing dietary behaviours by using educational techniques is more effective as compared to changing physical activity behaviours [32, 47].

2.2.2 Role of the environment in intervention effectiveness

Besides the fact that the home environment predicts or has been found to be associated with various health behaviours, the findings of the moderation study (chapter 7) provide some indication that for (computer-tailored) interventions to have an effect the home environment may play a facilitating role. For adolescents, parents are important agents in creating a supportive home environment. This might suggest that interventions to improve health related behaviours among adolescents should not solely target adolescents (e.g. via a school-based program), but should address parents as well. This is confirmed by a review showing that parental involvement enhances school-based intervention effectiveness [48]. A majority of the studies, however, while including a parental component, seemed to fall short of the needed depth of involvement [33]. At the same time, it is largely unknown how parents can be involved in adolescent obesity prevention efforts in an effective way. In addition, other environments, such as the neighbourhood and the school environment might support the effectiveness of an educational intervention. The study on the home environmental facilitators and barriers of the FATaintPHAT intervention presented in this thesis is one of the first of these kind

of studies published, but may be worthwhile to be pursued more often. Gaining better insight in how various environments may influence intervention effects can help in developing more efficient interventions.

2.2.3 Use of computer tailoring for adolescents

Understanding working mechanisms of computer tailoring can enhance intervention development and improvement. The study of FATaintPHAT can contribute to some extent to the understanding of how the intervention worked for adolescents. Since few stand alone computer-tailored intervention studies have been conducted among adolescents, the possible working mechanisms of computer tailoring among this population are still poorly understood. Possible working mechanisms of computer tailoring as described by Hawkins [49] - increased attention and effortful processing - are based on research among adults. It is likely that the same processes play a role in computer-tailored communication targeting adolescents, but such possible working mechanisms have not been systematically studied in the adolescent target group. It may also be that adolescents respond differently to individual feedback. Although adolescent are generally aware of health risks (they know that certain behaviours cause negative outcomes), adolescents tend to feel less personally vulnerable for risks and tend to be unrealistically optimistic when appraising their personal health risks [9, 50]. Haerens et al. [51] evaluated a physical activity computer-tailored intervention for adolescents and their results combined with the findings of the present study might provide some insights into whether computer tailoring works through the postulated working mechanisms among adolescents as well. First, attention as a possible working mechanism, was examined. We as well as Haerens et al. found that the adolescents reported to have read their tailored advice very well. This indicates that the attention to the messages was good [51]. Such high attention is postulated to lead to effortful (or 'central route') processing of the messages according to the Elaboration Likelihood Model. To further increase the likelihood of effortful processing, personal relevance is regarded to be important [52]. Both the present study and the one conducted by Haerens et al. found that information was perceived as moderate to high in personal relevance. However, the Elaboration Likelihood Model also points out that persuasion in the central route poses its own challenges. Effortful processing is more likely to include counter arguing, evaluations of credibility, and other processes that may lessen message effects [49], especially if the arguments brought forward to promote the healthful behaviours are not perceived as very strong [52]. At present there is little evidence as to what arguments for engaging in healthful energy balance behaviours are regarded as strong among adolescents. The study by Haerens et

al. [51] found that their messages were perceived as moderately to very credible by most students. More research to increase our understanding of the possible working mechanisms of computer tailoring among adolescents can help develop optimal computer-tailored interventions for this target group.

2.2.4 Differences in appreciation and effectiveness according to educational level

FATaintPHAT was developed for both vocational-training students as well as pre-university students (preparing for bachelor education). Tailoring is in theory very suited to appeal to adolescents in different levels of education and most studies that explored effect modification by education found no differences in effects among adults [53, 54]. In the study presented in this thesis, the intervention effects were not moderated by level of education for three of the four dietary behaviours. The effect on sugar-sweetened beverage consumption was, however, only found among pre-university students. This is thus somewhat contrary to earlier findings, although research among adolescents regarding dietary intakes is lacking. The results of the process evaluation indicated that the intervention was well appreciated and used by both vocational and pre-university students, but vocational students appreciated the intervention better, read it more carefully and more often discussed it with their parents. Such better appreciation of computer-tailored nutrition interventions by people with lower levels of education have been reported before [53, 55]. Our studies indicate that this does not necessarily mean that better appreciation is followed by more favourable effects. Pre-university students reported better comprehension of their tailored information, which may have led to better information processing.

3 METHODOLOGICAL CONSIDERATIONS

The FATaintPHAT study encounters some methodological strengths and weaknesses, regarding the design of the correlation and prediction studies, the design of the evaluation study, the study population and sampling, measurement and intervention use. These issues should be considered when interpreting the findings of the studies presented in this thesis.

3.1 Design of the correlates and predictors studies

With the exception of a study based on surveillance data from Texas, USA, the studies to explore potential determinants of energy balance presented in this thesis are based on the baseline or baseline and four month follow-up data of the control group of the FATainPHAT study. Cross-sectional as well as longitudinal analyses were conducted. Cross-sectional studies may inform us about mere associations, while longitudinal studies allow analyses of prediction; in general, results from longitudinal analyses are therefore regarded as more valuable. This thesis showed that different significant correlates, i.e. 'potential' determinants, can emerge from the two types of studies. Although longitudinal data are to be preferred in general, such data may also lead to biased results, especially regarding associations between potential behavioural determinants and behaviours. Potential behavioural determinants such as attitudes and intentions are liable to change. Lack of longitudinal associations between such potential determinants at baseline and behaviour at follow-up may therefore be due to such changes in determinants over time, disguising true relations. Therefore, optimal follow-up periods for longitudinal studies may be arbitrary and depending on the stability of the determinants. The strongest evidence on causality can be drawn from experiments where determinants are manipulated under controlled conditions and effects on the outcome are observed. However, proper mediation analyses are needed to analyze these relation and they require that the intervention was effective in changing the determinants. Moreover, experiments frequently lack strong external generalizability. Even though the studies described in this thesis have their limitations, it may be regarded as a strength of the presented studies that all included longitudinal analyses and in one study similar potential relationships were analysed both cross-sectionally and longitudinally. If both approaches lead to similar results this may be an indication for strength of the evidence .

Chapter 3 of this thesis is based on the assessment of two cross-sectional samples over time. As already mentioned, this design is generally regarded as weaker than a longitudinal design where individuals are followed over time and intra-individual changes can be observed. This is certainly true for the energy balance behaviour – anthropometrics association that was studied in this chapter. Cross-sectional associations may very well be the result of inverse causality, i.e. adolescents who are overweight may have changed their behaviours or may be more likely to provide biased self-reports. Longitudinal data are much more expensive and labour intensive to gather, but does allow to study direct associations between behaviours and anthropometrics over time. By using two cross-sectional samples it

remains unclear if changes in behaviours and changes in anthropometrics indeed occurred in the same individuals. Therefore, conclusions can only be drawn on an ecological level and although this study adds to the existing evidence, evidence from large scale longitudinal or experimental studies are needed to strengthen the evidence-base. A major strength of the design of the study reported in Chapter 3 is that the sample was state-representative, which enhances the generalizability of the results.

A well known threat to internal validity of correlate and predictor studies is confounding. Changes in the outcome may be attributable to the existence or variations in the degree of a third variable which is related to the predictor variable. Controlling for possible confounders, such as gender, educational level or ethnicity, as employed in the predictor studies in this thesis can eliminate confounding effects. It may however be very well possible that there were other unknown and unmeasured confounders that may influence associations that we could not adjust for.

3.2 Design of the evaluation study

The key question regarding internal validity of evaluation studies is whether observed changes can be attributed to the program or intervention (i.e., the cause) under study and not to other possible causes. To increase internal validity of an evaluation study two design aspects are of utmost importance: inclusion of a control group to eliminate effects of external influences and randomization to control for effects of selection bias. Moreover, it has been recognized that there is a need for large well-developed trials with both long and short term follow-up [31, 56] to assess effectiveness of programs to prevent excessive weight gain among children and adolescents. Therefore, the strengths of the FATaintPHAT study design are the size of the study (20 schools; 883 participants), the randomized controlled design, and the measurement of both short-term (4 months) and long-term follow-up (2 years) outcomes.

Limitations of the study are that we could not randomize the individual students, because this may have led to contamination between intervention and control group. Group randomized trials, such as the FATaintPHAT study have less power to detect differences between intervention and control group, and require more complex (multilevel) analyses due to the clustering of observations on the group level [57]. In the FATainPHAT study schools were randomized into the control or intervention group. Randomization on class level would have provided more groups

to randomize, but would also have increased the likelihood of contamination between classes. Cluster-randomization increases the likelihood of unsuccessful randomization (less units are randomized), which may lead to differences between intervention and control group. However, stratification according to educational level was performed before randomization to generate a more equal distribution of educational levels over intervention and control group. Another aspect that can introduce bias is lack of blinding. Participants, intervention implementers (school teachers) and researchers were not blinded for the allocation, possibly leading to differences between the intervention and control group that are not a result of the intervention per se, but might be the result of differences in reporting (students), teacher behaviour (teachers) or in interpretation (researcher). However, randomization was concealed until after the informed consent procedure to minimize the possibility of post-randomization selection bias.

Another important design aspect is the choice of the control group. In our study the control group continued their regular curriculum. This allowed us to study the effects of the intervention as compared to providing no (additional) intervention. We did not choose to have a control group who received generic non-tailored behavioural nutrition and physical activity education. Inclusion of such a control group would have allowed studying the effects of tailoring as compared to generic health education. We chose for a no intervention control group to provide evidence on the effects of the FATaintPHAT intervention as an intervention that can be implemented for the purpose of school-based health promotion. There are important consequences of using a no-intervention control group as compared to a generic-information control group: 1. The differences in effects between the two groups are likely to be larger with a no-intervention control group. The effect sizes found in the present study are effects that can be expected to occur when FATaintPHAT is introduced in schools where the regular curriculum was implemented. 2. No data on most process measures is available for the control group. Because the process measures focus on such issues as use and appreciation of the intervention, these cannot be administered among students who were not exposed to an intervention. Lack of such process data for the control group restrict the possibilities to analyse why the experimental intervention was or was not effective.

3.2.1 Study population and sampling

Participants were recruited in a two-step procedure. First, schools for secondary education were invited to participate. Twenty-three schools (vocational to pre-university education) were eligible and willing to participate. Second, adolescents

from one up to five classes in each school were invited to participate. Three schools withdrew from the study after randomization and before the baseline measurement. As dictated by medical ethics approval procedures in the Netherlands, students received information and an informed consent form for themselves and their parents, and only students for whom informed consent from themselves as well as one parent was available were eligible. Completed consent forms were returned to the schools. However, for three schools who initially agreed to participate in the study this informed consent procedure was too troublesome (forms were not returned to the schools by the students) and these schools withdrew from the study before the baseline measurement. Of the 1494 remaining students, 1156 (77%) returned their forms and 883 students (59%) agreed to participate in the study. As a result of this sampling and informed consent procedure, it is likely that our sample may be somewhat biased because of the selective response, both at the school and student levels.

3.2.2 External validity

The generalizability of the results of our study may be limited for several reasons. First, the selective sample might be a threat for the external validity possibly resulting in the outcomes not being applicable to schools and students with other characteristics than those who participated in the FATaintPHAT study. Passive instead of active consent might have diminished this bias. Second, the study was performed in the Rotterdam area, a large city in the Netherlands with a large ethnic minority population, on both vocational as well as pre-university educational level and included both boys and girls. However, since we did not find differential effects in appreciation or use for gender and ethnicity our results may apply to Western and non-Western adolescents and for boys and girls equally.

3.2.3 Measurements

The strengths of the measurements are the inclusion of objective measures of weight, height, waist circumference and physical activity. Limitations of the study are that the assessments of most behaviours were based on self-reports, which are prone to measurement error. Adapted versions of validated questionnaires were used for snack intake (correlation of 0.6 for fat intake with 7-day diet record) [58] and for fruit and vegetables intake (correlations of 0.53-0.64 for fruit intake and 0.22-0.35 for vegetable intake with 7-day diet record among adolescent [59], and correlations with plasma carotenoids and vitamin C of 0.39 and 0.37, respectively, for fruits and 0.24 and 0.26, respectively, for vegetables [60]). Test-retest reliability

coefficients for the physical activity sub-behaviours (including sedentary behaviour) vary between 0.68 and 1.00 [61]. Validity for sports and moderate activity frequency were r=0.52 (p<.01), for transport r=-0.19 (p>.05) and for sedentary behaviour r=-0.13 (p>.05) [61]. These validity scores range from reasonable to low. Moreover, for sugar-sweetened beverages and fibre intake no validated instruments were available. A 24-hour recall is found to be superior over a frequency questionnaire to get reliable estimates of group mean intake levels and to detect differences between groups [62, 63]. Therefore, if available in our dataset, we used 24-hour recall questions for the analyses. If no 24-hour recall was available (i.e. for physical activity, sedentary behaviours, snack and whole wheat bread consumption) we used the food frequency questionnaires. We believe that we used the best questionnaires available for use in school-based surveys among larger samples, however, as already mentioned, the validity is mediocre at best. More precise self-report measures are available for food intake, such as multiple 24 h recalls or diary methods, and for some dietary behaviours certain biomarkers may be valid estimates of intakes, but such more extensive self reports or drawing blood samples were expected to lower the participation rates of schools and students, and no budget was available for more extensive measurements [64].

The measures used for the assessment of the cognitions and the environmental factors had good face validity, but were not subjected to validity or reproducibility tests. Little research has been performed in measuring cognitions among adolescents, which might be different from the assessment among adults due to more limited comprehension of specific values. As a result, it might be more difficult to detect association between cognitions and behaviours among adolescents.

3.2.4 Intervention development and implementation

The FATaintPHAT intervention was developed according to the planned approach of health promotion as also outlined in the introductory chapter [65]. This planned approach utilizes the available evidence and theory to identify important risk behaviours, related determinants and methods to change the determinants, increasing the chances that the developed intervention is effective [66]. Furthermore, combining promotion of healthful dietary and physical activity behaviours has been found to be most promising in prevention of overweight and obesity [31, 34, 67, 68]. However, convincing evidence with regard to the specific behaviours and their behavioural determinants that need to be addressed to indeed contribute to prevention of overweight is still limited (see Chapter 1). Such evidence should be improved to enhance the development of future interventions.

The intervention was well implemented in schools, where 80 percent of the students completed the program. However, fidelity outcomes showed that only two of the eleven intervention schools implemented the program as pre-specified in the teacher manual in eight different lessons. Other teachers implemented the program in one to six lessons. It appeared that although schools are highly equipped with computers, making the reservations for these facilities require some time and effort which was perceived as the main barrier by the teachers for implementation as intended.

4 IMPLICATIONS OF THE STUDY FINDINGS

The results presented in this thesis have several implications for future research and public health practice. Recommendations for future research are based on questions that remain after or are evoked by our studies. Recommendations for practice are related to the use of FATaintPHAT to prevent excessive weight gain among adolescents in the Netherlands.

4.1 Implications for research

4.1.1 Risk behaviours and determinants

An important limitation in developing the intervention was that the evidence with respect to behavioural risk factors and underlying individual and environmental determinants of such behaviours was limited. Therefore, it is important that more research is directed at:

1. Identification of risk behaviours and clusters of specific dietary, physical activity and sedentary behaviours that are related to excessive weight gain among adolescents. It is most likely that clusters of risk behaviours or behavioural patterns rather than single behaviours are important. Studies with longitudinal and experimental designs with a sufficiently long follow-up period and utilisation of reliable, valid and preferably objective assessments of risk behaviours are especially needed.
2. Identify cognitive, social and environmental determinants related to energy balance-related behaviours. Since only few studies have been conducted in this field there is an urgent need for longitudinal and experimental studies to identify determinants of the different behaviours. These studies should address theoretically plausible cognitive determinants and consider different phases and aspects of behaviour and behaviour change, such as motivational

and volitional determinants as well as habit. Home and school are important environments for children and adolescents and the result of this thesis indicate that research into the influence of especially the home environment on dietary, physical activity and sedentary behaviours should be studied further. Both objective and perceived - by child and parent - environmental factors may contribute to understanding the relationship between environment and behaviour.

4.1.2 Computer tailoring

To build evidence on the efficacy and effectiveness of computer tailoring as a suitable technique for changing energy balance-related behaviours among adolescents, more small and large scale evaluation studies are required. More precisely, there is a need for studies directed at:

3. better understanding of the efficacy of computer tailoring for adolescents. Therefore, more efficacy studies on computer-tailored interventions are needed among adolescents. These studies should also explore differential effects according to educational levels and environmental characteristics.
4. better understanding of the working mechanisms of computer tailoring for adolescents. More in depth understanding of information processing mechanisms is needed to improve future computer-tailored interventions. In addition, differential processes for lower and higher educational levels should be explored. This requires more controlled laboratory studies in which message attention, information processing and the role of perceived personal relevance or information credibility can be studied.
5. research to identify how computer-tailored interventions for adolescents can be more effective, for instance by adding more sessions, longer intervention duration, concurrently creating a supportive environment or the use of stronger behaviour change techniques.

4.1.3 Methodology

The quality of studies in the field of behaviour change could be improved by using better outcome measures.

6. More research is needed on identifying better measurement instruments to assess dietary, physical activity and sedentary behaviours. Since we often aim to measure subtle behaviour changes we need sensitive measurement instruments that are valid and reliable. The development and use of more objective measurements instead of self report might enhance both the validity and reliability.

4.2 Implications for practice

1. Results of the evaluation study indicated that the intervention was effective in modifying dietary behaviours with reasonable effect sizes and, therefore, the dietary modules of FATaintPHAT relating to the consumption of sugar-sweetened beverages, snacks, fruit and vegetables can be implemented in practice to improve these dietary behaviours.
2. The modules of the intervention that do not have a favourable effect should be improved to enhance the effectiveness. In depth study is needed to inform this adaptation of the fibre, physical activity and sedentary behaviour modules.
3. Implementation of FATaintPHAT by the teachers should be facilitated by adapting the intervention and teacher manual for allowing implementation in fewer lessons. The intervention can be implemented in schools for vocational and pre-university education and may be combined with other interventions, such as adaptations of the school canteen and more physical activity classes.
4. It may be important to target parents to facilitate a supportive home environment for adolescents when implementing an educational intervention among adolescents. Studies in this thesis showed that the home environment is an important determinant of adolescents' sugar-sweetened beverage consumption and may be a prerequisite for intervention effects on vegetable consumption.

5 GENERAL CONCLUSION

The computer-tailored FATaintPHAT intervention did not have a significant impact on anthropometric outcome measures. The intervention was, however, successful in improving self-reported dietary behaviours among Dutch adolescents at the short-term. The intervention was generally effective for the demographic subgroups based on gender, educational level and ethnicity. Moreover, the intervention was well appreciated and used by adolescents from both genders, all educational levels and ethnic backgrounds, although appreciation was somewhat higher among adolescents attending vocational training. These results suggest that computer tailoring can be an effective and appreciated strategy for changing adolescents' dietary behaviour. The dietary modules of the FATaintPHAT intervention can be implemented in the school curriculum of the various educational levels, as an intervention aimed at improving dietary behaviours. However, none and unfavourable effect have been found for fibre, physical activity and sedentary behaviours. Therefore, these modules need further adaptations and evaluation. In accordance with many other school-based interventions, FATaintPHAT was not

effective in improving weight-related outcomes. Since the relation between important energy balance-related behaviours is still an important topic of research, better understanding of the role of single or clusters of these behaviours might inform future intervention development for the prevention of excessive weight gain. Home environmental factors are likely to be related to adolescents' behaviour (such as the consumption of sugar-sweetened beverages) and to intervention effectiveness (for vegetable consumption). Therefore, targeting parents to create a supportive home environment in addition to an individual level intervention may be a promising new avenue for improving effects of the intervention. Since the FATaintPHAT intervention was one of the first studies on computer tailoring among adolescents and shows promising effects, more in depth studies of computer tailoring for adolescents are needed to inform future intervention development for this target group.

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SUMMARY

The high prevalence of overweight and obesity is an important cause of avoidable burden of disease in the Netherlands and worldwide. Preventing 'excessive' weight gain (i.e. weight gain beyond what is needed for normal growth and development) among adolescent can contribute to reducing this burden. However, effective interventions to prevent excessive weight gain in young people are largely lacking. Intervention development should be guided by a planned approach, in which the health problem, the behavioural risk factors for these health problems and the behavioural determinants of these risk factors are systematically studied.

Excessive weight gain is caused by an excess energy intake as compared to the energy needs over a longer period of time. Although some knowledge is available on important energy balance-related behaviours and their determinants, sufficient understanding to inform optimal intervention development is currently lacking. However, using the available knowledge on risk behaviours, interventions to contribute to the prevention of excessive weight gain may focus on improving specific dietary behaviours, such as reducing the consumption of sugar-sweetened beverages and energy-dense snacks, and increasing the intake of fruit, vegetables and fibre; physical activity behaviours, such as sports participation; and decreasing sedentary behaviours such as television viewing. Based on theory and evidence, potentially important determinants to target are personal factors such as attitudes, subjective norms, perceived behavioural control, intentions, and awareness, and environmental factors such as availability and accessibility. Insights into probable important behavioural determinants have been documented in different theoretical models. School-based interventions are promising in improving health behaviours among adolescents. Moreover, the technique of computer tailoring, where users receive individually adapted feedback and advice, have shown to be promising in improving dietary behaviours and may also positively affect physical activity behaviours among adults.

Given the abovementioned insight and gaps in knowledge this thesis has two larger aims:

- To contribute to the understanding of specific dietary, physical activity and sedentary behaviours that are related to the energy balance and the personal and environmental predictors among adolescents (Chapters 2 till 4).
- To evaluate the main and differential effects, use, and appreciation of FATaint-PHAT, a computer-tailored health education program aimed to contribute to the prevention of excessive weight gain among adolescents (Chapters 5 till 8).

In **chapter 2** the psychosocial and demographic predictors of the intention to prevent excessive weight gain among adolescents aged 12-13 years is studied. The intention to prevent excessive weight gain may be an important driver for preventive actions regarding weight management and is therefore a potentially important factor to target in interventions aimed at the prevention of excessive weight gain. To be able to modify the intention to prevent excessive weight gain, it is important to have insight in the underlying factors. The results of this study showed that a majority of the adolescents aged 12 to 13 years had a positive intention to prevent excessive weight gain, but that they did not feel personally at risk for gaining excessive weight. Moreover, this positive intention was predicted by a positive attitude (considering the prevention of excessive weight gain as good and important) and high perceived internal control (the belief that prevention of excessive weight gain is under their own control). Therefore, creating a positive attitude and increase the sense of control may be important elements in interventions aimed at motivating adolescents to prevent weight gain. Such Interventions should then improve the sense that the prevention of excessive weight gain is something good and important and provide support to help adolescents to control their dietary, physical activity and sedentary behaviours. However, it is important to study whether and how a positive intention to prevent excessive weight gain is related to the performance of weight control behaviours.

In **chapter 3** the contribution of important dietary, physical activity and sedentary behaviours to obesity development were studied. For most of these behaviours no conclusive evidence is available, which warrants further research of this topic. The study presented in chapter 3 of this thesis adds to this field of research by presenting the results of secondary data analysis of a large surveillance study in Texas, USA, the School Physical Activity and Nutrition (SPAN) study. The results suggest that the following behaviours may contribute to the prevention of obesity in children: sports team participation, limiting television viewing and cereal consumption. The results of the SPAN study further provide some indications for a protective role for regular meal patterns and the consumption of milk products, however, supporting evidence for these behaviours is still limited and more research is needed. Although these results add to the current evidence, more research is certainly required.

Although the SPAN study did not provide indications that sugar-sweetened beverage consumption was associated with the risk for excessive weight gain, recent reviews have indicated that high intakes of such beverages are associated with higher risk for weight gain, overweight and obesity. In **chapter 4** we studied personal

cognitive factors as well as family food rules and perceived home availability of sugar-sweetened beverages as predictors of change in sugar-sweetened beverages consumption using longitudinal data. Results of this study show that adolescents who believe that they are capable of reducing sugar sweetened beverage intake and with a more positive attitude to decrease sugar-sweetened beverages intake were more likely to decrease their intake. In addition, adolescents in households where sugar-sweetened beverages are highly available and a family food rule that allowed them to (almost) always drink as much sugar sweetened beverages as they liked, were more likely to increase their intake as compared to students with low availability and a stricter parental rule. The association between low availability and decrease in sugar-sweetened beverage consumption was almost completely mediated by a higher perceived behavioural control. This study is one of the first to provide some evidence for the important role of the home environment on dietary intake among adolescents.

The studies described above and presented in chapters 2 through 4 provide input to inform intervention development. In addition, in the chapters 5 through 8 the development and evaluation of FATaintPHAT is described. **Chapter 5** describes the planned development of the FATaintPHAT intervention and the study design for evaluating the effectiveness, use and appreciation of the intervention. FATaint-PHAT is a web-based computer-tailored intervention to prevent excessive weight gain among adolescent aged 12 to 13 years old by improving dietary behaviours (reducing the consumption of sugar-sweetened beverages and high energy snacks, increasing intake of fruit, vegetables, and whole wheat bread), sedentary behaviour (reducing television viewing and computer use), and physical activity (increasing active transport to school, leisure time activities and sports). The FATaintPHAT study is one of the first to study the effects of a computer-tailored intervention that addresses seven energy balance-related behaviours and one of the first to evaluate a stand-alone computer-tailored intervention for adolescents. FATaintPHAT is based on the Theory of Planned Behaviour, the Precaution Adoption Process Model and implementation intentions. In eight separate modules the concept of weight management and the seven energy balance-related behaviours are addressed. Each module consists of a brief introduction to the topic with information about the behaviour-health link, an assessment of behaviour and determinants, individually-tailored feedback on behaviour and determinants and an option to formulate an implementation intention to prompt specific goal setting and action planning. The feedback provided included several elements: behavioural feedback, comparing the student's behaviour with guidelines for that behaviour (normative feedback), and with behaviour of peers (comparative feed-

back), prompts for intention formation, decisional balance information to change attitudes, prompts for barrier identification and instructions on how to perform/ change a behaviour to improve self-efficacy, and suggestions on how to organise social support. Before interventions can be implemented in practice it is important to test the effects of the intervention. The effects of the FATaintPHAT intervention were evaluated in a two-group cluster randomised trial (n=883) with assessments at baseline, 4-months (school year 2006-2007) and 2-years follow-up (school year 2008-2009). Twenty schools in Rotterdam and surrounding municipalities were randomised into an intervention or a no-intervention control group. The intervention was evaluated for effects on anthropometrics (BMI, waist circumference) and fitness at 2-years follow-up, and energy balance-related behaviours (dietary, physical activity and sedentary) at 4-months and 2-years follow-up. The study was conducted in collaboration with the Municipal Health Services in the Rotterdam area.

In **chapter 6** the short- and longer term results of the evaluation of the FATaintPHAT intervention are presented. Results indicate that FATaintPHAT had no effects on anthropometric outcomes at 2-years follow-up. Some favourable effects were found on self-reported dietary behaviours at 4-months follow-up (adolescents in the intervention group consumed less sugar-sweetened beverages, ate less snacks, and more vegetables compared to those in the control group), but not at 2-years follow-up. Unexpected negative effects were found for total step count at four-month follow-up. No effects on whole wheat bread consumption, sedentary behaviour and the physical activity behaviours were found. Among students who were not acting according to recommended intake or activity levels and therefore would have received an advice to improve their behaviours, there was in addition an effect on fruit consumption, but not for sugar-sweetened beverages intake, and some unfavourable effects for physical activity behaviours (sports participation and step counts) at 4-months follow-up.

The aim of the study in **chapter 7** was to identify whether the intervention was equally effective for specific subgroups of adolescents, according to socio-demographic, cognitive and home environmental factors. The results of these analyses indicate that the intervention was equally effective for boys and girls, for students of Western and non-Western backgrounds, and for students engaged in higher as well as lower education levels. An exception to these general non-differential effects was observed for sugar-sweetened beverage consumption; the effect was only observed among students attending pre-university level education. Moreover, increased fruit intake was only observed among students who at baseline were

aware of their low fruit intake levels. This moderation effect was not observed for the other dietary behaviours. The intervention effects were not moderated by intention. Finally, the effect on vegetable intake was only observed among students who reported high availability of vegetables at their homes, indicating that high availability of vegetables is a prerequisite for an intervention effect for vegetables intake, but not for the other behaviours. Analysis of possible moderators and in particular the role of the home environment in computer-tailored interventions for adolescent is an important topic for further research.

Besides evaluating the effects of an intervention, it is important to study how the intervention was used and appreciated. This information can help in interpreting the effects or lack of effects of the intervention and can give directions for how to improve the intervention and the intervention implementation. The process evaluation (**Chapter 8**) showed that 81% of the students had been exposed to all intervention modules and 73% reported to have put the advice into practice. Half of the students reported to appreciate the tailored advice positively, while one third was neutral. The average grade (on a scale of 1 (negative) to 10 (positive)) was a 7.1. Vocational training students appreciated the intervention somewhat better compared to students attending pre-university education. However, no associations were found between appreciation and use and changes in behaviour.

In the general discussion (**Chapter 9**) the findings of all studies are integrated, strengths and limitation are presented and conclusion and recommendation for future research and practice are given. Important conclusions of this thesis are summarized below. The computer-tailored FATaintPHAT intervention did not have a significant impact on anthropometric outcome measures. The intervention was, however, successful in improving self-reported dietary behaviours among Dutch adolescents at the short-term. The intervention was generally equally effective for boys and girls, higher and lower education students, and students from Western and non-Western backgrounds. Moreover, the intervention was well appreciated and used by adolescents, independent of gender, level of education and ethnic background, although the appreciation was somewhat better among adolescents attending vocational training. These results suggest that computer tailoring can be an effective and well-appreciated strategy for changing adolescents' dietary behaviour. The dietary modules of the FATaintPHAT intervention can be implemented in the school curriculum of the various educational levels, as an intervention aimed at improving dietary behaviours. However, lack of effect and even some unfavourable effects were found for fibre intake, physical activity and sedentary behaviours. Therefore, these modules need further adaptation and evaluation. In

accordance with many other school-based interventions, FATaintPHAT was not effective in improving weight-related outcomes. Since the relation between important energy balance-related behaviours is still an important topic of research, better understanding of the role of single or clusters of these behaviours might inform future intervention development for weight gain prevention. Home environmental factors are likely related to adolescents' energy balance behaviours. Therefore, targeting parents to create a supportive home environment in addition to an individual level intervention may be a promising new avenue for improving effects of the intervention. Since the FATaintPHAT intervention was one of the first studies on computer tailoring among adolescents and shows promising effects, more in depth studies of computer tailoring for adolescents are needed to inform future intervention development for this target group.

SAMENVATTING

Overgewicht en obesitas zijn de oorzaak van veel ziekten en aandoeningen, zoals hart- en vaatziekten, diabetes en gewrichtsaandoeningen. Het voorkomen van overmatige gewichtstoename (d.w.z. een gewichtstoename die groter is dan mag worden verwacht volgens normale groei en ontwikkeling) bij adolescenten kan bijdragen aan het verminderen van deze ziekten en aandoeningen. Echter, er zijn op dit moment weinig effectieve interventies beschikbaar om overmatige gewichtstoename bij jongeren te voorkomen. Voor het ontwikkelen van een effectieve en efficiënte interventie is het belangrijk om een planmatige aanpak te volgen, waarbij het gezondheidsprobleem, de risicofactoren van dit gezondheidsprobleem en de determinanten van deze risicofactoren systematisch worden onderzocht.

Overmatige gewichtstoename wordt veroorzaakt door een langdurige verstoring van de energiebalans, waarbij de energie inname (door eten) hoger is dan het verbruik (door te bewegen en de energiebehoefte van het lichaam). De beschikbare kennis over de gedragingen die in belangrijke mate verband houden met de energie balans en de factoren die dat gedrag bepalen (determinanten), is op dit moment nog onvoldoende voor het optimaal ontwikkelen van interventies. Echter, de kennis die beschikbaar is suggereert dat interventies die bijdragen aan de preventie van overmatige gewichtstoename zich moeten richten op het verminderen van de inname van gesuikerde dranken en energierijke snacks; het verhogen van de fruit-, groente- en vezelconsumptie; het stimuleren van voldoende bewegen, zoals sporten; en het verminderen van zittend gedrag zoals televisie kijken of computeren. Op basis van kennis uit theorie en wetenschappelijke onderzoek kan vervolgens gekeken worden welke belangrijke determinanten van invloed zijn op deze gedragingen. Een interventie moet dan ingaan op die belangrijke determinanten om te zorgen dat de gedragingen veranderen en overgewicht wordt voorkomen. Er worden verschillende soorten persoonlijke en omgevingsdeterminanten onderscheiden. Persoonlijke determinanten zijn bijvoorbeeld attitude, subjectieve normen, ervaren gedragscontrole, intentie en bewustzijn van het eigen gedrag; omgevingsfactoren zijn bijvoorbeeld de aanwezigheid en de toegankelijkheid van producten en diensten. Uit onderzoek blijkt dat interventies die op school worden uitgevoerd om gezond gedrag bij jongeren te verbeteren veelbelovend zijn. Ook blijkt advies-op-maat via de computer, een techniek waarbij iedere gebruiker feedback en advies ontvangt dat speciaal voor hem of haar is gemaakt, veelbelovend voor het bevorderen van voedingsgedrag en mogelijk ook beweeggedrag bij volwassenen. Het is daarom aannemelijk dat advies-op-maat ook bij jongeren gedragsverandering kan stimuleren.

Om de mogelijkheden voor de preventie van overmatige gewichtstoename verder te onderzoeken heeft dit proefschrift twee algemene doelen:

- Bijdragen aan het vergroten van het inzicht in welke specifieke voedings-, beweeg- en zittende gedragingen sterk samenhangen met de energie balans, en het vergroten van het inzicht in persoonlijke en omgevingsdeterminanten van deze gedragingen bij adolescenten (hoofdstukken 2 t/m 4).
- Evalueren van effecten, gebruik en waardering van VETisnietVET, een internet advies-op-maat programma om overmatige gewichtstoename bij adolescenten te voorkomen (hoofdstukken 5 t/m 8).

Om overmatige gewichtstoename bij jongeren te voorkomen is het in eerste instantie belangrijk dat jongeren gemotiveerd zijn om daar iets aan te doen. In **hoofdstuk 2** worden de psychosociale en demografische determinanten van de intentie (of motivatie) om overmatige gewichtstoename bij jongeren te voorkomen bestudeerd bij adolescenten van 12-13 jaar. De intentie om overmatige gewichtstoename te voorkomen is mogelijk een belangrijke drijfveer voor het nemen van preventieve maatregelen voor gewichtsbehoud. Het is daarom belangrijk om in interventies op deze factor in te gaan. Om de intentie om overmatige gewichtstoename te voorkomen te verhogen is het belangrijk om inzicht te verwerven in factoren die de intentie bepalen. De resultaten van deze studie laten zien dat de meerderheid van de adolescenten een positieve intentie had om overmatige gewichtstoename te voorkomen, maar dat zij tegelijkertijd geen hoog risico ervoeren om dikker te worden. Een positieve intentie werd voorspeld door een positieve attitude (ervaren dat het voorkomen van overmatige gewichttoename goed en belangrijk is) en een hoge ervaren interne controle (het gevoel dat je zelf controle hebt over het voorkomen van overmatige gewichtstoename). Daarom lijken het creëren van een positieve attitude en het verhogen van een gevoel van controle belangrijke elementen in interventies om de intentie van adolescenten om overmatige gewichtstoename te voorkomen belangrijk. Dergelijke interventies zouden het gevoel dat het voorkomen van overmatige gewichtstoename goed en belangrijk is moeten bevorderen en zouden adolescenten moeten ondersteunen bij het bevorderen van gezond voedings-, beweeg- en zittend gedrag. Echter, het is belangrijk om te onderzoeken of en hoe een positieve intentie samenhangt met daadwerkelijk gedrag om overmatige gewichtstoename te voorkomen.

In **hoofdstuk 3** werd onderzocht welke specifieke voedings-, beweeg- en zittende gedragingen bijdragen aan het ontstaan van obesitas. Voor de meeste van deze gedragingen is er nog geen sluitend bewijs voor de relatie met obesitas. Dit maakt het nodig om hier nog uitvoeriger onderzoek naar te doen. De resultaten van

secundaire data analyse van een grote observationele studie in Texas, USA, de 'School Physical Activity and Nutrition' (SPAN) studie, wijzen erop dat deelname aan een teamsport, beperken van televisie kijken en de consumptie van ontbijtgranen bijdragen aan het voorkomen van obesitas bij kinderen. Daarnaast geven de resultaten van de SPAN studie enige aanwijzing dat een regelmatig eetpatroon en de inname van melk producten kan bijdragen aan het voorkomen van obesitas. Echter, ondersteunend bewijs voor de samenhang van deze gedragingen met obesitas zijn beperkt en verder onderzoek is daarom noodzakelijk.

In tegenstelling tot de resultaten van de SPAN studie, laten recente overzichtstudies zien dat hoge inname van gesuikerde dranken samenhangt met een hoger risico op gewichtstoename, overgewicht en obesitas. In **hoofdstuk 4** is een studie uitgevoerd naar de voorspellende waarde van persoonlijke cognitieve factoren, voedingsregels en aanwezigheid van gesuikerde dranken thuis op een verandering in de consumptie van deze dranken. De resultaten laten zien dat adolescenten die overtuigd zijn dat zij de inname van gesuikerde dranken kunnen beperken en adolescenten die een positieve attitude hadden om minder gesuikerde dranken te drinken vaker hun consumptie verminderden over een periode van vier maanden. Verder bleek dat adolescenten uit gezinnen waar gesuikerde dranken altijd aanwezig zijn en die zo veel gesuikerde dranken mogen drinken als ze willen vaker meer frisdrank gingen drinken vergeleken met adolescenten waar thuis minder frisdrank aanwezig was en ouders regels hadden over hoeveel frisdrank ze mogen drinken. Dat een lagere beschikbaarheid thuis samenhangt met een afname in het drinken van gesuikerde dranken komt doordat jongeren dan meer controle ervaren over het drinken van gesuikerde dranken. Deze studie is een van de eerste studies die de belangrijke rol van de thuisomgeving op het voedingsgedrag van adolescenten laat zien.

De studies die hierboven en in de hoofdstukken 2 tot en met 4 beschreven zijn geven informatie die van belang is voor interventieontwikkeling. In de hoofdstukken 5 tot en met 8 wordt de ontwikkeling en evaluatie van VETisnietVET beschreven. **Hoofdstuk 5** beschrijft de planmatige ontwikkeling van de VETisnietVET interventie en de studieopzet voor het evalueren van de effectiviteit, het gebruik en de waardering van de interventie. VETisnietVET is een internet advies-op-maat interventie om overmatige gewichtstoename bij adolescenten van 12 tot 13 jaar te voorkomen door het verbeteren van voedings- (verminderen van de consumptie van gesuikerde dranken en snacks, verhogen van fruit, groente en volkorenbrood inname), beweeg- (toename in actief transport naar school, bewegen in de vrije tijd en sport), en zittend gedrag (verminderen van televisie kijken en computer

gebruik). De VETisnietVET studie is een van de eerste studies die het effect van een advies-op-maat interventie die zich richt op zeven energiebalans gerelateerde gedragingen en een op zichzelf staand advies-op-maat programma voor adolescenten onderzoekt. VETisnietVET is gebaseerd op de Theorie van Gepland Gedrag, het 'Precaution Adoption Process Model' en implementatie intenties. In acht verschillende modules wordt ingegaan op het concept van gewichtsbehoud en zeven energiebalans gerelateerde gedragingen. Iedere module bestaat uit een korte introductie op het onderwerp met informatie over de relatie tussen het gedrag en gezondheid. Dan vullen jongeren een vragenlijst over het gedrag en determinanten in. Vervolgens krijgt iedere adolescent individueel op maat gemaakt advies over zijn/haar gedrag, wat hij/zij daar aan zouden kunnen veranderen en hoe hij/zij dat zou kunnen doen. Ook kan iedere adolescent een persoonlijk plan maken (implementatie intentie) om te bepalen wát hij/zij precies wil veranderen en hoe hij/zij dat wil gaan doen en acties te plannen. Het advies bevat de volgende elementen: terugkoppeling op het gedrag, het vergelijken van het gedrag van de jongere met de richtlijnen (normatieve terugkoppeling), en met het gedrag van andere jongeren (vergelijkende feedback), stimulans voor het formuleren van een gedragsintentie, informatie voor het heroverwegen van attitudes, informatie voor het identificeren van barrières, praktische informatie over hoe je een gedrag kunt veranderen om de ervaren controle over het gedrag te vergroten en suggestie hoe je sociale steun kunt organiseren.

Voordat een interventie in de praktijk kan worden geïmplementeerd is het belangrijk om de effecten van een interventie te evalueren. De effecten van de VETisnietVET interventie zijn geëvalueerd in een cluster gerandomiseerde studie met twee groepen (n=883), met een voormeting, een meting na vier maanden (schooljaar 2006-2007) en na twee jaar (schooljaar 2008-2009). Twintig scholen in Rotterdam en omgeving werden op basis van toeval verdeeld in een interventie en een controle groep. De controlegroep kreeg geen interventie. De interventie werd geëvalueerd op effecten op lichaamsmaten (BMI (Body Mass Index (kg/m^2)), middelomtrek) en fitheid twee jaar na de voormeting, en op energiebalans gerelateerd gedrag (voedings-, beweeg- en zittend gedrag) vier maanden en twee jaar na de voormeting. De studie werd uitgevoerd in samenwerking met de GGD Rotterdam-Rijnmond.

In **hoofdstuk 6** worden de korte- en lange termijn resultaten van de effectevaluatie van VETisnietVET gepresenteerd. De resultaten laten zien dat VETisnietVET geen effect had op de lichaamsmaten van de jongeren twee jaar na de voormeting. Gunstige effecten werden gevonden op zelfgerapporteerd voedingsgedrag vier

maanden na de voormeting (adolescenten in de interventie groep dronken minder gesuikerde drank, aten minder snacks en aten meer groente vergeleken met de adolescenten in de controle groep), maar niet twee jaar na de voormeting. Onverwachte negatieve effecten werden gevonden voor het aantal stappen gemeten met een stappenteller vier maanden na de voormeting: de jongeren in de interventiegroep liepen minder. Er werden geen effecten gevonden op de inname van volkorenbrood, zittend gedrag, transport naar school en sporten. Bij jongeren die op de voormeting niet aan de aanbevelingen voor inname of activiteit voldeden en die daarom het advies kregen om hun gedrag te verbeteren, werd aanvullend een gunstig effect op fruit inname, maar niet op de inname van gesuikerde drank gevonden, en bovendien een aantal ongunstige effecten op het beweeggedrag (sport deelname en aantal stappen) vier maanden na de voormeting.

Het doel van de studie in **hoofdstuk 7** was om na te gaan of de interventie even effectief was in het bevorderen van gezond eten voor jongens of meisjes, jongeren op een lager of hoger schoolniveau, jongeren met een westerse of niet-westerse achtergrond, jongeren die zicht bewust of niet bewust waren van een ongunstige inname, jongeren die meer of minder positief stonden tegenover een verbetering in inname en jongeren waarbij thuis meer of minder gezonde producten aanwezig waren. De resultaten van de analyses lieten zien dat de interventie even effectief was voor jongens als voor meisjes, adolescenten op het vmbo en havo/vwo/gymnasium en voor adolescenten met een westerse en niet-westerse achtergrond. Een uitzondering hierop was dat een effect op de consumptie van gesuikerde dranken alleen werd gevonden bij jongeren die havo, vwo of gymnasium volgden. Wat betreft de cognitieve kenmerken, een toename in fruitconsumptie werd alleen gevonden bij adolescenten die zich op de voormeting bewust waren van hun te lage fruitconsumptie. Voor de effecten op de andere voedingsgedragingen was er geen verschil bij een laag of hoog bewustzijn van de inname. Er waren ook geen verschillende effecten bij een lage of een hoge intentie om het gedrag te verbeteren. Tot slot, het effect op de groente inname werd alleen gevonden bij adolescenten die aangaven dat er veel groente thuis aanwezig was. Dit geeft aan dat het in hoge mate aanwezig zijn van groente thuis een voorwaarde is voor een interventie-effect op groente consumptie, maar niet voor de andere voedingsgedragingen. Analyses van factoren die het effect van een interventie beïnvloeden en in het bijzonder de rol van de thuisomgeving in advies-op-maat interventies voor adolescenten is een belangrijk onderwerp voor toekomstig onderzoek.

Naast het evalueren van de effecten van een interventie is het belangrijk om te weten hoe de interventie is gebruikt en gewaardeerd door de jongeren. Met deze

informatie kunnen de resultaten van de studie beter worden begrepen en kunnen adviezen worden gegeven voor het verbeteren en het implementeren van de interventie. De proces evaluatie (**hoofdstuk 8**) laat zien dat 81% van de jongeren alle interventieonderdelen heeft doorlopen en 73% heeft aangegeven de informatie ook gebruikt te hebben. De helft van de adolescenten waardeerde de adviezen positief, terwijl een derde van de adolescenten neutraal was. Het gemiddelde cijfer (op een schaal van 1 tot 10) was een 7.1. De vmbo leerlingen waardeerden de interventie enigszins beter dan de havo, vwo en gymnasium leerlingen. Er werd geen relatie gevonden tussen de waarderingen of het gebruik van de interventie en verandering in gedrag.

In het discussie hoofdstuk van dit proefschrift (**hoofdstuk 9**) zijn de bevindingen van alle studies samengevoegd, sterke en zwakke punten besproken en conclusies en aanbevelingen voor toekomstig onderzoek en de praktijk gegeven. Belangrijke conclusies van dit proefschrift zijn hieronder samengevat. De advies-op-maat interventie VETisnietVET had geen significant effect op de lichaamsmaten. De interventie was echter wel succesvol in het verbeteren van zelfgerapporteerd voedingsgedrag op de korte termijn, onder Nederlandse adolescenten. De interventie was in het algemeen even effectief voor jongens en meisjes, voor vmbo en havo, vwo en gymnasium leerlingen en voor jongeren van een westerse en een niet-westerse afkomst. Bovendien werd de interventie goed gewaardeerd en gebruikt door jongeren, onafhankelijk van geslacht, opleidingsniveau en etnische afkomst, alhoewel bij de vmbo jongeren de waardering wat beter was. Deze resultaten laten zien dat advies-op-maat een effectieve en gewaardeerde strategie kan zijn om het voedingsgedrag van jongeren te verbeteren. De voedingsmodules van VETisnietVET kunnen worden gebruikt op scholen met verschillende opleidingsniveaus om het voedingsgedrag van jongeren te verbeteren. Er werden echter geen, of zelfs ongunstige effecten gevonden voor de inname van volkorenbrood, bewegen en zittend gedrag. Deze modules moeten daarom aangepast en opnieuw geëvalueerd worden. Zoals bij veel schoolinterventies wordt gevonden, was VETisnietVET niet effectief in het verbeteren van gewichtsgerelateerde uitkomsten. De relatie tussen (clusters van) belangrijke energiebalans gerelateerde gedragingen met overgewicht en obesitas is nog steeds een belangrijk onderwerp van onderzoek. De resultaten hiervan kunnen bijdragen aan de ontwikkeling van toekomstige interventies voor de preventie van overmatige gewichtstoename. De thuisomgeving is waarschijnlijk geassocieerd met energiebalans gerelateerde gedragingen, waardoor het beïnvloeden van ouders om een ondersteunende thuisomgeving te creëren in aanvulling op individuele interventies voor jongeren een veelbelovende mogelijkheid is voor het vergroten van interventie effecten.

Aangezien de VETisnietVET studie een van de eerste studies is op het gebied van advies-op-maat voor jongeren en veelbelovende effecten laat zien, zijn meer verdiepende studies over advies-op-maat bij jongeren nodig om de ontwikkeling van toekomstige interventie voor deze doelgroep te ondersteunen.

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Onderzoek in het algemeen en promotieonderzoek in het bijzonder doe je niet alleen, gelukkig maar. Ik heb met velen samengewerkt, wat heeft bijgedragen aan zowel het plezier in het werk als de kwaliteit ervan.

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Ik heb een gezellig tijd gehad op MGZ en veel geleerd. Dat is natuurlijk te danken aan vele collega's! Een aantal mensen wil ik daarbij speciaal noemen: mijn kamergenoten: Willemieke, Else Mariette en Frank; Tinneke, Wendy, Tilja, Elin, Hein, Meeke, Rick, Suzan, Lenneke, Lidy, Carlijn, Vicki, Merel, Karien, Esther, Pepijn, Amy, Britt, Jitske, Klazine, Nannah en Saskia. Speciale dank ook aan mijn onderzoeksmedewerkers, zonder wie ik het onderzoek nooit had kunnen uitvoeren: Marieke, Nelly en Marleen.

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My visiting fellowship at the School of Public Health in Austin, Texas, was a memorable period of my life. I enjoyed working together with many inspiriting

researchers! A special thanks to Deanna, Sandra, Marty and Andrew. Let's kick some piñatas!

Natuurlijk wil ik ook de scholen, docenten en leerlingen die hebben meegewerkt aan het onderzoek bijzonder bedanken, omdat zonder hun enthousiaste inzet er geen onderzoeksresultaten zouden zijn geweest. Ik hoop dat de resultaten van deze studie hun weg naar de scholen zullen vinden.

Lieve vrienden en familie. Ik waardeer jullie vriendschap, steun en liefde meer dan ik in het algemeen laat blijken. Papa en mama. Voor jullie is het wetenschappelijk onderzoek toch maar een ondoorgrondelijke wereld. Hopelijk geeft dit boekje en de verdediging ervan straks een beter beeld van wat mijn promotieonderzoek inhield.

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OVER DE AUTEUR - ABOUT THE AUTHOR

Nicole Ezendam is geboren op 19 november 1976 in Hengelo. In 1995 behaalde zij haar VWO-diploma aan het Grundel College in Hengelo. Zij is vervolgens Biomedische Wetenschappen gaan studeren aan de Universiteit van Leiden. In haar laatste jaar heeft zij de postdoctoraal cursus Beleid, Bestuur en Natuurwetenschappen gevolgd aan de Vrije Universiteit. In 2000 is zij afgestudeerd, waarna ze heeft gewerkt als projectmedewerker en projectmanager bij de Nederlandse Hartstichting (tot 2002), als projectmedewerker en projectcoördinator bij het Regionaal Bureau Gezondheidszorg Zuid-Holland Noord (tot 2003), als onderzoeker bij de afdeling Medische Informatiekunde van het Leids Universiteir Medisch Centrum (tot 2005). Naast deze laatste baan is zij gestart met de Public Health Master van het Nihes (Netherlands Institute for Health Sciences) in Rotterdam. In 2006 is Nicole gestart aan haar promotieonderzoek bij de afdeling Maatschappelijke Gezondheidszorg van het Erasmus MC wat resulteerde in dit proefschrift. In 2007 heeft zij haar Public Health Master afgerond. Als deel van haar promotieonderzoek heeft ze in 2008 drie maanden aan de School of Public Health van de University of Texas in Austin gewerkt. In 2009-2010 werkte zij naast haar promotieonderzoek als coördinator op het nationale CIAO (Consortium Integrale Aanpak Overgewicht) project. Vanaf medio 2010 werkte zij als onderzoeker aan de doorontwikkeling van VETisnietVET bij de afdeling Maatschappelijke Gezondheidszorg op een door haarzelf verkregen subsidie van het NISB (Nederlands Instituut voor Sport en Bewegen). Vanaf juli 2011 werkt ze als post-doc bij het Integraal Kankercentrum Zuid (IKZ) in Eindhoven en de Universiteit van Tilburg, School of Social and Behavioral Sciences. Nicole woont in Breda, is getrouwd met Rian Hamhuis en heeft twee kinderen Rowan en Annika.

Nicole Ezendam was born on the 19th of November 1976 in Hengelo, the Netherlands. In 1995 she completed her secondary education at the Grundel College in Hengelo. Thereupon she started at Leiden University the study Biomedical Science. In her final year she completed a postdoctoral course 'Beleid, Bestuur en Natuurwetenschappen' at the 'Vrije Universiteit'. In 2000 she graduated, whereupon she worked as a projectmanager at the Netherlands Heart Foundation (until 2002), as projectworker and projectcoordinator at the 'Regionaal Bureau Gezondheidszorg Zuid-Holland Noord' (until 2003), as researcher at the department of Medical Informatics of the Leiden Univerity Medical Center (until 2005). During this latter job she started with the Master of Public Health of the Nihes (Netherlands Institute for Health Sciences) in Rotterdam. In 2006 Nicole started her PhD study at the department of Public Health at the Erasmus MC which resulted in this dissertation.

In 2007 she graduated from her Public Health Master. As part of the PhD training she went abroad for three months to the University of Texas, School of Public Health in Austin. In 2009-2010 she was also project coordinator of the national CIAO (Consortium Integrale Aanpak Overgewicht) project. Starting midway 2010, she worked as a researcher on the adaptation of FATaintPHAT at the department of Public Health on an own grant from the NISB (Nederlands Instituut voor Sport en Bewegen). Since July 2011 she works as a post-doc at the Comprehensive Cancer Center South in Eindhoven and the University of Tilburg, School of Social and Behavioral Sciences. Nicole lives in Breda, is married to Rian Hamhuis and has two children Rowan and Annika.

LIST OF PUBLICATIONS

Van de Poll-Franse LV, Nicolaije KAH, Vos MC, Pijnenborg JMA, Boll D, Boss EA, Hermans RHN, Engelhart KCM, Haartsen JE, Pijlman BM, Feijen HWH, Mertens HJMM, Nolting WE, Ezendam NPM, Van Beek JJ, Roukema JA, Kruitwagen RFPM. Rationale and Study Protocol of ROGY Care: A pragmatic cluster randomized controlled trial in gynecological cancer patients to assess the impact of a cancer Survivorship Care Plan on patient and health care provider reported outcomes. (submitted)

Van Grieken A, Ezendam NPM, Paulis WD, Van der Wouden JC, Raat H. Effects of interventions to decrease sedentary behavior for overweight prevention in children and adolescents: a meta-analysis. (submitted)

Ezendam NPM, Noordegraaf VSA, Kroeze W, Brug J, Oenema A. Process evaluation of FATaintPHAT, a computer-tailored intervention to prevent excessive weight gain among Dutch adolescents. (submitted)

Ezendam NPM, Brug J, Borsboom G, Van Empelen P, Oenema A. Differential effects of the computer-tailored FATaintPHAT program on dietary behaviors, according to socio-demographic, cognitive and home environmental factors. (submitted)

Ezendam NPM, Oenema A, Brug J. Predictors of the intention to prevent unnecessary weight gain among adolescents. (submitted)

Ezendam NPM, Brug J, Oenema A. Evaluation of a tailored intervention to promote energy balance in youth: a RCT. Archives Pediatrics & Adolescent Medicine. (in press)

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Reparon-Schuijt, CC, Van Esch, WJE, Van Kooten, C, Ezendam, NPM, Levarht, EWN, Breedveld, FC, Verweij, CL Presence of a population of CD20+, CD38- B lymphocytes with defective proliferative responsiveness in the synovial compartment of patients with rheumatoid arthritis. Arthritis and rheumatism. 2001 44(9): 2029-37

PHD PORTFOLIO

SUMMARY OF PHD TRAINING AND TEACHING ACTIVITIES

Name PhD student:	Nicole Ezendam
Erasmus MC Department:	Public Health
PhD period:	May 2006 – August 2010
Promotors:	J.Brug, PhD
	J.P.Mackenbach, PhD
Supervisor:	A.Oenema, PhD

1. PhD training

	Year	Workload (Hours)
General courses		
Medical writing course	2006	40
Didactic skills	2008	80
Specific courses		
Public health in the European Union (Nihes)	2006	40
Public health research (Nihes)	2006	160
Multilevel analysis (Nihes)	2006	24
Repeated measurements	2007	40
Maternal and child health (Nihes)	2007	40
Ethnicity, health and health care (Nihes)	2007	40
Psychiatric epidemiology (Nihes)	2007	40
Analysis of time-varying exposures (Nihes)	2007	40
Planning Health Promotion Programs: an intervention mapping approach	2007	16
Seminars and workshops		
Department of Public Health seminars	2006-2010	100
WEVO seminars	2006-2010	16
Organizing and presenting pre-conference workshop on computer-tailoring. ISBNPA, Oslo, Norway	2007	32
Organizing and presenting workshop on computer-tailoring. Philips, Eindhoven, Netherlands	2007	16

Organizing and presenting pre-conference workshop on computer-tailoring. ISBNPA Minneapolis, USA	2010	16
Presentations		
Design and evaluation protocol of a computer-tailored intervention to prevent excessive weight gain in adolescents. ISBNPA, Oslo, Norway.	2007	16
VETisnietVET, preventie van overgewicht via advies-op-maat aan brugklassers. Oral presentation for the CEPHIR seminar, Rotterdam, Netherlands	2007	16
FATaintPHAT (Dutch: VETisnietVET). A study on the impact of a computer-tailored intervention on energy balance-related behaviours and weight in youth. Seminar, Austin, Texas, USA	2008	16
Short-term evaluation of a computer-tailored intervention targeting multiple energy balance-related behaviours among adolescents. Oral presentations at the ISBNPA conference, Banff, Canada	2008	16
VETisnietVET: E-health op het voortgezet onderwijs preventie van overgewicht via advies-op-maat. CEPHIR seminar, Rotterdam, the Netherlands	2008	16
Psychosocial predictors of the intention to prevent unnecessary weight gain among adolescents: a longitudinal study. Poster presentation at the ECO conference, Amsterdam, Netherlands	2009	16
Cognitive and home environmental predictors of change in sugar-sweetened beverage consumption among adolescents. Oral presentations at the ISBNPA conference, Portugal	2009	16
Do trends in physical activity, sedentary and dietary behaviors support trends in obesity prevalence in two border regions in Texas? Poster presentation at the ISBNPA conference, Portugal	2009	16
VETisnietVET, een interventie ter preventie van overmatige gewichtstoename bij adolescenten: korte- en lange-termijn effecten. Oral presentation at the 'Nederlands Congres Volksgezondheid', Rotterdam, Netherlands	2010	16

Short- and long-term effects of FATaintPHAT, a computer-tailored intervention to prevent unnecessary weight gain among adolescents. Oral presentation at the ISBNPA conference, Minneapolis, USA	2010	16
FATaintPHAT: Short and long term impact of a computer-tailored intervention targeted at energy balance-related behaviours and weight in youth. Oral presentation at the EHPS conference, Cluj, Roemenia	2010	16
FATaintPHAT, a computer-tailored intervention to prevent excessive weight gain in youth: Effect and process outcomes. Research meeting department of Public Health, Rotterdam	2010	16
VETisnietVET, een interventie ter preventie van overmatige gewichtstoename bij adolescenten: korte- en lange-termijn effecten. WEVO seminar, The Hague, the Netherlands	2010	16
(Inter)national conferences		
Conference of the International Society of Behavioral Nutrition and Physical Activity, Oslo, Norway	2007	24
Conference of the International Society of Behavioral Nutrition and Physical Activity, Banff, Canada	2008	24
European Congress on Obesity, Amsterdam, Netherlands	2009	24
Conference of the International Society of Behavioral Nutrition and Physical Activity, Portugal	2009	24
British Drinking and Feeding Group, Maatricht, Netherlands	2010	16
Nederlands Congres Volksgezondheid, Rotterdam, Netherlands	2010	16
Conference of the International Society of Behavioral Nutrition and Physical Activity, Minneapolis, USA	2010	24
Conference of the European Health Psychology Society, Cluj, Roemenia	2010	24

2. Teaching activities

	Year	Workload (Hours)
Lecturing		
Skills training	2007-2010	30
Supervision of writing task	2007-2010	20
Nihes lecture: computer-tailored health education. Planned development and evaluation	2009	4
Supervising Master's thesis		
A process evaluation of FATaintPHAT: a computer tailored web-based intervention aimed at improving energy balance-related behaviours in order to prevent excessive weight gain among adolescents	2010	45