The Schoolgruiten Project
Evaluation of a primary school fruit and vegetable scheme in the Netherlands

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Evaluation of a primary school fruit and vegetable scheme in the Netherlands

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op gezag van de rector magnificus
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General introduction
GENERAL INTRODUCTION

Introduction
This thesis reports on a number of studies examining different aspects of the Dutch Schoolgruiten Project, an intervention aimed at increasing fruit and vegetable (F&V) consumption among primary schoolchildren in the Netherlands. This general introduction describes the relevance of such a project and the background of the Schoolgruiten Project. The structure and outline of this thesis are presented at the end of this chapter.

Planned Health Promotion
In recent years the importance of careful theory-based and systematic health behaviour intervention planning has been recognized. Therefore a simple model (see FIGURE 1.1) for planned health education and promotion has been advocated and endorsed. Within this model, five different phases or steps can be distinguished. According to this model, phase I in health promotion planning is the identification of health problems that are serious and/or prevalent enough to justify the allocation of resources for their prevention. In phase II the behavioural risk factors for the health problems need to be identified. Subsequently, the personal, social, and environmental mediators or determinants of these risk factors are identified in phase III. These three phases refer to the needs assessment. The needs assessment is followed by intervention development in phase IV. In this phase, interventions should be formulated, based on the identified behavioural determinants. Furthermore, this phase should identify or develop intervention methods that induce changes in the behavioural determinants and subsequently reduce the risk behaviour or promote healthy behaviour. These methods are then translated into implementable interventions strategies and evaluated for their efficacy (phase V). Subsequently, interventions should be implemented and disseminated in such a way that the target population is reached as well as possible. Each step of the model should be based on careful evaluation. The next paragraphs describe how the Schoolgruiten Project fits within this model of planned health promotion.
FIGURE 1.1 A model for planned health education and promotion

**Needs assessment**

In the Netherlands and in most other Western countries cardiovascular diseases, cancer and overweight, contribute substantially to morbidity and mortality ratios. Risk behaviours related to the development of these diseases are mainly found in lifestyle factors, among others, nutrition behaviour. F&V intake is one of the dietary behaviours that is endorsed to contribute to a healthy lifestyle. By now, epidemiological evidence for an association between eating enough F&V and a decreased risk for chronic metabolic diseases like obesity, hypertension and diabetes mellitus type 2 is regarded as convincing and high intakes of F&V are part of official recommendations for healthy eating in many countries. Promoting F&V intakes is also one of the eight recommendations of the World Cancer Research Fund (WCRF) as this agency advocates that a higher F&V intake may significantly contribute to the prevention and control of cancer throughout the world. The WCRF report of 2007 recommends consuming at least five portions (400 grams) of F&V per person per day.

However, in most Western countries, a considerable proportion of the population, including children, does not comply with these dietary recommendations. As shown in a recent European study, F&V intakes are lower than the national guidelines. This is also the case for adults and children in the Netherlands. In 1998, Dutch children’s average daily intake for fruit was less than one serving a day and, for vegetables, children’s intake was only 70 grams. In the study conducted by Yngve et al. in 2003, Dutch 11-year-old children were ranked among the lowest consumers of F&V compared...
with children from other European countries. The Dutch recommendations for F&V intake for 10 to 12-year-old children are two pieces of fruit (about 200–250 grams) and 150–200 grams of vegetables per day.

Therefore, the Dutch government as well as non-governmental health promotion agencies have incorporated F&V promotion as an important part of their health promotion efforts among the general population and among schoolchildren in particular. To date, attempts have been undertaken to promote F&V intakes through various interventions, among both adults and children. It is important to aim at schoolchildren, since there is increasing evidence that adoption of a healthy lifestyle in childhood is associated with health and well-being in adulthood. Besides, food habits acquired in childhood to a certain extent continue into adolescence and adulthood. Moreover, behavioural habits in children may not be as firmly rooted as in adults.

Besides Schoolgruiten, the intervention tested in the present thesis, several campaigns and interventions have been conducted in and outside the Netherlands aiming at the promotion of F&V intakes among primary schoolchildren. In the Netherlands, projects such as Pro Children (funded by the European Union) and Vita + Froet are examples of other intervention attempts. Examples of projects outside the Netherlands are the 5-a-day campaign implemented in the United States of America, the Norwegian intervention ‘Fruit and Vegetables Make the Marks’, the National School Fruit Scheme of England and the British ‘Food Dudes’ programme.

Analysis of determinants of F&V intake

In order to change behaviour, we need to gain insight into the most important and modifiable determinants of the behaviour in question. Dietary behaviours are influenced by such factors as availability and accessibility of foods; familiarity with foods; physiological processes like hunger and thirst; inborn taste preferences; cultural, social, and personnel norms; prosperity; attitudes; intentions; and other cognitions. For the current study, we relied on existing theoretical models, a review of the literature, and an analysis on potential determinants of F&V intake to study such potential determinants further (see chapter three).

Which determinants influence behaviour have been described in theoretical models, of which the Theory of Planned Behaviour (TPB) and the very similar Attitude, Social Influence, and Self-Efficacy model (ASE) are well known and frequently used. These Social Cognitive models assume that behaviour is the result of a more or less rational decision-making process. These models focus on the motivational process leading to certain behaviour via the intention to engage in that behaviour. The TPB posits that
behaviour is directly predicted by the intention to perform and perceptions of control over the behaviour. Intentions represent a person’s motivation in the sense of his or her decision to exert effort to perform the behaviour. Intention is itself determined by three sets of factors: attitudes, subjective norms and perceived behavioural control (PBC). PBC is thus presumed to have a direct effect on behaviour as well as an indirect effect via intention. Attitude is a weighing of perceived or expected advantages and disadvantages of engaging in the behaviour, in this case the expected or perceived pros and cons of eating enough F&V. Subjective norm is the perceived opinion of other people in the direct social environment about the particular behaviour, e.g. if you think important others want and expect you to eat enough F&V. PBC is the individual’s perception of someone’s own ability to have control over the particular behaviour. It reflects whether a person considers himself or herself as being able to change (having enough skills) or not. Other variables such as physical environment (e.g. availability and accessibility of F&V) and physiological (e.g. hunger) factors are regarded as more distal determinants of behaviour in those social cognitive models and are expected to influence behaviour via the abovementioned proximal determinants.

Several studies tested whether the TPB could indeed predict F&V intake, however, these studies were conducted among an adult population. Bogers et al. concluded, in a study exploring potential determinants of F&V consumption based on the TPB, that PBC was the strongest predictor of intentions and behaviour. Brug et al. concluded, in a study about predictors of fruit intake, that the TPB constructs indeed predict fruit intake. A study conducted in the USA examined whether the TPB explained intentions and consumption of five servings of F&V per day over a two-week period and concluded that affective attitude and PBC were the dominant predictors of intention to eat F&V.

Besides cognitive variables, environmental variables have been related to F&V intake as well. A distinction can be made between the physical environment, such as availability of F&V, and the social environment, such as parents who act as positive role models. The recently proposed Environmental Research framework for weight Gain prevention (EnRG) proposed however, that environmental factors can have both direct and indirect effects on health behaviour, i.e. via cognitive factors such as attitude, subjective norm, and PBC. An environment that offers many opportunities to consume F&V, i.e., where availability and accessibility is high, may result in higher consumption of F&V. A review by Rasmussen et al. showed indeed that availability and accessibility are among the most important correlates of F&V intakes among primary schoolchildren. Besides, these two environmental factors, the review also showed that taste preferences was an important correlate of F&V. Taste preferences is not an environmental factor or one
of the variables of the TPB, but, according Rothschild, taste preferences belongs to the category of motivation\textsuperscript{37}. The results of this review suggest that interventions should therefore aim at improving these correlates\textsuperscript{36}. A review of interventions to promote F&V among children further suggested that multi-component interventions that improve availability and accessibility of F&V and that include activities to improve taste preferences for F&V are most promising\textsuperscript{34}. A recent cross-European study that applied these ingredients in a comprehensive intervention (i.e., the Pro Children Study) showed promising effects\textsuperscript{38}. Recently, a systematic review of the effectiveness of interventions to promote F&V consumption in children in schools has been published\textsuperscript{39}. The conclusion of this review was that school F&V schemes are effective at increasing intake and knowledge. Of the 30 studies included, 70% showed increased F&V intake, partly due to improved availability. Twenty-three studies had follow-up periods of at least one year and these provide some evidence that F&V schemes can have long-term impacts on F&V consumption.

**Intervention development and description of the Schoolgruiten Project**

Based on knowledge from the literature and previous experiences, the Dutch F&V Produce Promotion Group (AGF Promotie Nederland), together with the Dutch Horticulture Marketing Board (Productschap Tuinbouw) and the Ministry of Health, Welfare and Sport (Ministerie van VWS), developed the Schoolgruiten Project. ‘Schoolgruiten’ is a Dutch acronym for ‘school fruits and vegetables’. The main determinant addressed in this intervention was availability of F&V at school. The strategy used was providing, twice a week, a serving of fruit or vegetable for free to all children during school hours. Additionally, a school curriculum aiming at increasing knowledge and skills related to F&V consumption was offered to the schools. The Schoolgruiten Project was implemented in seven cities of the Netherlands (Almelo, Breda, Deventer, Dordrecht, Leiden, The Hague, and Zwolle). In total, nearly 75,000 children in these seven cities received free F&V twice a week during the course of the intervention.

**Evaluation of the Schoolgruiten intervention**

It was important to evaluate the developed Schoolgruiten intervention in order to determine whether it had the expected outcome (effect evaluation) weighed against acceptable costs (economic evaluation), and if the intervention was implemented as planned (process evaluation).

The Schoolgruiten Project was and still is meant to grow into a nationwide campaign for primary schoolchildren, but it started with a pilot phase in which the intervention was tested in a controlled design, to inform further improvement of the intervention.
or justify further implementation. This pilot phase started in 2003 and ended after two years in 2005.

The effectiveness of the Schoolgruiten Project was evaluated by means of a quasi-experimental design, with a pre-test and two post-tests, and an intervention and control group (see chapters five and six). Primary schools from two cities (The Hague and Almelo) were assigned to the intervention group and schools from three other comparable cities (Zoetermeer, Leidschendam, and Hengelo) were assigned to the control group. All fourth-grade children (aged 9–10 years) from primary schools in these five cities were eligible for participation in this evaluation study. The baseline measurement was conducted prior to the start of the intervention in 2003. First follow-up among the same children was one year later and second follow-up, again among the same children, was conducted two years later. Separate questionnaires containing parallel questions assessing the child’s F&V intake and related variables for children and their parents were used. Results from these surveys were used to compare F&V intakes between children from the intervention schools and children from the control schools. As well as this outcome evaluation, there was an assessment of whether children appreciated the intervention programme. Furthermore, costs were documented and compared with modelled future effects of the Schoolgruiten intervention (see chapter eight).

Outline of this thesis

The overall aim of the current thesis was to study correlates of F&V intakes among primary schoolchildren and to evaluate the Schoolgruiten intervention. Chapters two and three will describe studies on potential determinants of F&V intake, of which chapter two will give an overview of the presumed most important determinants of F&V intakes among schoolchildren with a specific emphasis on taste and taste preferences, based on reviews of the literature and using results from two specific studies. Chapter three used the longitudinal data available in the Schoolgruiten study to assess whether changes in potential determinants were associated with changes in intake. Chapter four focuses on methodology, describing the questionnaire used to assess F&V intake among children and to test the agreement between parent and child reports of the children’s intake levels. The last part of the thesis, chapters five to eight, will describe the impact evaluation and economic evaluation of the Schoolgruiten intervention. The short-term effects, stratified by ethnicity, are described in chapter five, while chapter six will report the long-term effects, i.e., after two years into the intervention. In addition, it was assessed whether the intervention affected the kind of snacks brought from home to school, i.e., whether the intervention resulted in bringing F&V to school to
be consumed during the mid-morning break more often and unhealthful snacks less often. These results are described in chapter seven. In chapter eight, an economic evaluation of the Schoolgruiten and the Pro Children intervention will be described. A comparison was made between the two Dutch interventions and also ‘no intervention or doing nothing’. In the final chapter – chapter nine – the main findings of this thesis will be summarised. Further, the results will be discussed and integrated in the general discussion. Theoretical, practical, and methodological issues derived from this thesis will be discussed, as well as implications for public health and directions for further research.

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Part I

Determinants of schoolchildren’s fruit and vegetable intakes
Taste preferences, liking and other factors related to fruit and vegetable intakes among schoolchildren: results from observational studies

Paper published as:
Chapter 2

ABSTRACT

The present paper explores the relative importance of liking and taste preferences as correlates of fruit and vegetable (F&V) intakes among schoolchildren in Europe. The paper first provides an overview of potential determinants of food choice among children and subsequently summarizes the results of two recent observational studies on determinants of F&V intakes among school-aged children. It is proposed that taste preferences and liking are important for children's food choices as part of a broader spectrum of nutrition behaviour determinants. Taste preferences and liking are important for motivation to eat certain foods, but social-cultural and physical environmental factors that determine availability and accessibility of foods, as well as nutrition knowledge and abilities should also be considered.

Study 1 shows that children with a positive liking for F&V have a greater likelihood to eat fruits (odds ratio, (OR) =1.97; 98% confidence interval (CI): 1.52–2.55) or vegetables (OR=1.60; 98% CI: 1.41-1.80) every day, while ability and opportunity related factors such as knowledge, self-efficacy, parental influences and accessibility of F&V were also associated with likelihood of daily intakes (ORs between 1.16 and 2.75). These results were consistent across different countries in Europe. Study 2 shows that taste preferences were the strongest mediators of gender differences in F&V intakes among children; the fact that girls eat more could for a large extend be explained by their stronger taste preferences.
INTRODUCTION

Diet and nutrition clearly play a critical role during childhood and adolescent development. First of all, children and adolescents need to cover not only their nutrient and energy needs for maintenance metabolism and physical activities, but also for growth. Furthermore, eating habits may be less established in childhood and adolescence, and may therefore be better modifiable, and food preferences and habits adopted in childhood and adolescence may track to a certain extend into adulthood.

Nutritional habits are not in line with recommendations among children and adolescents. Many young people eat not enough fruits and vegetables, too much saturated fat, and more energy than they need. In order to promote more healthful eating, we need to know why children and adolescents eat what they eat.

What, when and how much children eat is influenced by a complex, interrelated set of so-called behavioural ‘determinants’ and successful dietary behaviour change interventions are dependent on the identification of the most important and best changeable determinants, because intervention strategies, methods and materials need to be selected or developed that are tailored to the target populations and to the most important and best modifiable determinants of behaviour change.

In this paper we will first give a brief overview of different important categories of determinants of food choice and dietary intake among children and adolescents. Secondly, we will present and discuss the results of two recent observational studies on determinants of fruit and vegetable (F&V) intakes that illustrate the relative importance of taste preferences and liking as compared to other potential determinants of F&V consumption among school-aged children across Europe.

Determinants of food intake: motivation, ability and opportunity

In affluent countries, most people can generally choose what, when and how much they eat. To induce dietary change, one needs to change people’s food choices. Studies on personal determinants of food choice have primarily made use of psychological theories to explain food choice and nutrition behaviours. It has, however, been argued that, since children may have less autonomy in making food choices, environmental rather than personal factors may be more important determinants of their nutrition behaviours. More recently, social-ecological models of health behaviour have drawn more attention to such environmental influences on nutrition behaviours. A framework proposed by Rothschild provides a simple, integrative framework to categorise the large and diverse number of potential personal and environmental determinants from...
various more specific behaviour theories. Rothschild identifies three distinct categories of determinants: motivation, ability and opportunity. These categories of determinants are interrelated. For example, in environments with few opportunities for healthful eating, higher motivation and more abilities are needed to maintain a healthful diet.

**Motivation**

Behavioural decision, motivation or intention have been identified as primary determinants of behaviour. Motivation or intention is influenced by a subjective weighing of expected positive and negative consequences of the behaviour. In general, expectations about short-term outcomes are more important than longer-term outcomes. Taste, satiety and pleasure are short-term consequences of major importance. Taste preferences and liking are regarded as key determinants of food choice. People, and young people maybe more so, eat what they like, and disliked foods are avoided. Certain taste preferences are innate, such as a liking for sweet and salt, and a dislike for bitter and sour. However, taste preferences can be learned and unlearned. ‘Hunger’ or appetite is also a strong motivator to eat. In Maslov’s hierarchy of human needs, the need to cover physiological energy requirements, i.e. overcoming hunger, is among the highest human priorities, and the urge to eat and drink when hungry is an inborn trait. Since eating is primarily a way to cover the basic physiological nutrient requirements and calorie requirements, satiety, i.e. the feeling that energy requirements have successfully been met, is a strong reinforcer for eating specific foods and we therefore quickly learn to like and appreciate energy-dense foods. Children are therefore ‘programmed’ to like, or to learn to like, the taste of high-energy, sweet and fatty foods. Nevertheless, many acquire a taste for coffee, tea or beer during childhood and adolescence, which shows that we can even unlearn our innate dislike of bitter.

Some specific types of taste preference learning strategies have been identified. The aforementioned example of learning to like high-energy foods is referred to as ‘taste-nutrient learning’. Taste-nutrient learning is an example of operant or instrumental conditioning: a stimulus (eating energy dense, sweet and fatty food) is positively reinforced (‘rewarded’) by the pleasant feeling of satiety. In the last decades palatable energy-dense foods have become readily available and accessible for most children in Western countries. This abundance combined with our innate preference for energy-dense foods may be an important cause for the present-day obesity epidemic. Research shows that high-fat and sugar-rich foods are indeed among the most preferred foods among children and adolescents. Most fruits and especially vegetables have low-energy densities, and many vegetables have a somewhat bitter taste. Preferences for these foods are therefore not so easily learned.
Two other food preference-learning strategies are examples of classical conditioning and are referred to as ‘taste-taste learning’ and ‘taste-environment learning’. If a new, unfamiliar, taste is combined with a taste for which a preference already exists, children will more easily learn to like the new taste. For example, children will more easily learn to like the somewhat bitter taste of tea or the sour taste of yoghurt or grapefruit, if these are first served with sugar. Similarly, a liking for tastes that people are exposed to in pleasant physical or social environments are also learned. Foods first encountered as a child in a friendly, pleasant family environment, may become favourite foods for a lifetime.

A fourth important learning strategy is observational learning or modelling: children learn to like the taste of foods that they see their parents, siblings, friends or other ‘important others’ eat.

Health related beliefs may also be important. If people are asked about what they find important in their diet and food choice, ‘health’ usually comes second (or third) after ‘taste’ (and cost), especially among women. Nevertheless, 40% of Americans and 57% of Europeans indicated rarely or never to compromise on taste to improve the healthfulness of their diets. This is probably even more likely among children. Motivation and intentions are important determinants of nutrition behaviours, and taste preferences and liking importantly influence motivation to eat. But not all behaviour is intentional, and we not always act on our intentions. Lack of abilities or lack of environmental opportunities can be important barriers. Environmental cues may also trigger automatic behavioural responses.

**Ability**

Self-efficacy, or perceived behavioural control (PBC), refers to one’s confidence in one’s abilities and skills to engage in certain behaviour. PBC is behaviour and context specific. A person can, for example, be confident to be able to eat less fat, but not to increase vegetable intake; and confidence to cut back on fat may be high for regular meals prepared at home, but not for eating out. PBC is strongly related to abilities and skills. Studies in children and adolescents show that food and nutrition-related self-efficacy is associated with healthful food choices and dietary behaviour. Skills and abilities are to some extent dependent on practical knowledge. For example, knowing why to eat healthfully, knowing what healthful foods are, and knowing the recommended intake levels may all be conditional for voluntary healthful eating. Although knowledge in itself is unlikely to result in healthful food and nutrition choices – knowledge may be a necessary but insufficient condition for healthy food choice –, some recent studies show that knowledge of recommended intake levels of F&V was associated with higher intakes in 11-year old school children.
Environmental opportunities
Children and adolescents’ opportunities to make healthful dietary choices strongly depend on the opportunities their environments have to offer. For example, children’s social environment, such as their parents and school staff, importantly influences their range of food choices; their physical environment, such as where they live or go to school, importantly influences what foods are available and accessible to them.

Classifying the food environment
The ANGELO framework \(^{24}\), which was specifically developed to conceptualise health behaviour environments related to obesity, distinguishes four ‘types’ of environments: physical, economic, political, and socio-cultural. The physical environment refers to availability of healthy and unhealthy choices, such as points-of-purchase for F&V and soft drink vending machines in schools. The economic environment refers to the costs related to healthy and unhealthy behaviours, such as the price of soft drinks, F&V or energy-dense snacks in school cafeterias. The political environment refers to the rules and regulations that may influence food choice and eating behaviour. Bans on soft drink vending machines in schools, rules on what treats can and cannot be brought to school, as well as family food rules are micro-level political environmental factors. Other examples are national school food policies or national legislation regarding food-marketing efforts aimed at children. The socio-cultural environment refers to the social and cultural subjective and descriptive norms and other social influences such as social support for adoption of health behaviour and social pressure to engage in unhealthy habits.

Evidence for environmental determinants of nutrition behaviours in youth
Child and adolescent dietary behaviour is likely to be strongly influenced by environmental factors, since children may have less autonomy in food choice. From the age of about three years, children’s eating behaviour is influenced by their responsiveness to environmental cues, and a variety of family and social factors start to influence children’s eating behaviours \(^{25}\). The role of parents and schools is considered to be of particular importance.

Parent and family influences
Parents directly and importantly determine the child’s micro-level social, political, physical as well as economical nutrition environments. Eating is a social behaviour, especially for children \(^{2}\), and observing eating behaviours of others, especially parents, influences their own preferences and behaviour. Such modelling of eating behaviours
can even result in establishing preferences for foods or substances that are inherently disliked. A recent review of the literature on environmental correlates of nutrition behaviours in youth indicates that children and adolescents’ nutrition behaviours are consistently associated with their parents’ behaviours. Parents further influence their offspring’s nutrition behaviours by actively encouraging, discouraging or controlling certain behaviours. Restricting children’s access to, for example high fat or sugar-rich foods, may encourage rather than discourage preferences for such foods, especially if these same foods are also used to reward children for good behaviour and for celebrations. However, a study conducted in Belgium indicated that clear restrictive family rules about high fat foods during childhood were associated with healthier food choices in adolescence, and a recent cross-European study showed that parental demand as well as facilitation to eat F&V were associated with higher intake levels in 11 year old children, while ‘parental allowance’ (i.e. parents allowing children to eat as much as they like), was not.

From studies on the association between general parenting styles and children’s health behaviours, it appears that authoritative parenting, i.e. a parenting style characterised by high parental involvement as well as strictness, is associated with more positive health behaviours including higher F&V intakes, compared to adolescents who reported authoritarian (high strictness, low involvement) or neglectful (low strictness, low involvement) parenting styles.

As a result of these parenting practices and rules, as well as parents’ own food preferences and choices, parents influence what foods are available and accessible within the home environment. Availability and accessibility of foods have repeatedly been found to be associated with intake levels in children and adolescents.

Finally, family socio-economic position is important. A recent review of the literature confirmed that low parental education, as well as parental income is associated with less healthful diets in children and adolescents.

**School influences**

A second important setting for children and adolescent nutrition is the school environment. Children spend much time at school; consume a large proportion of their daily intakes there, and schools offer nutrition education as part of the regular curriculum.

Accessibility and availability of foods in schools are important physical environmental factors. In many countries across Europe, schools provide lunch or other foods for the students, with great differences between countries. For example, in Belgium school lunches are offered in a majority of primary and secondary schools. Parents need to
pay for their children to have a school lunch, children are allowed to bring their own lunch to school, and the school lunches are not required to meet official dietary guidelines. Most secondary schools do have vending machines and snack food outlets. In the Netherlands, a neighbouring country, school lunches are not offered. In primary schools, children go home for lunch or children need to bring their lunch to school. In secondary schools, adolescents bring their lunch to school, or they can buy lunch in the school a la carte cafeteria. In Sweden and the UK primary and secondary schools do offer free school lunches but while Swedish schools are required to meet official recommended intake levels, nutrition requirements for school lunches in the UK only state that meals in primary schools should contain at least one item from four major food groups (starchy foods; F&V; dairy products; meat, fish or alternative protein source) and in secondary school lunches at least two items from each of these groups should be offered. Preliminary evidence from the European Pro Children Study indicates that school lunches can make a difference; Swedish kids eat more vegetables at school than children from other countries across Europe, and have a relatively high total daily vegetable intake.

**Macro-level environment**

An important macro-level factor is how foods are marketed to children and adolescents. Children and adolescents are increasingly seen as an important target group for food marketing. Young people in affluent countries have money to spend themselves, they may also influence food-buying behaviours of their parents, and they are the future adult buyers and consumers. Foods that are most intensively marketed by means of advertisement and marketing campaign are foods that are high in sugar and fats, and often low in micronutrients. In the US fast food restaurants and soft drink companies spent most on marketing their products. The large portion sizes offered at ‘value pricing’ (i.e. larger portions cost relatively less), especially in the US, is a marketing strategy that has probably contributed to higher caloric intakes and unnecessary weight gain. Television still is the most important channel for marketing food products, especially for younger children, but food marketing among youth also includes, for example, school-based marketing, Internet advertising, and sponsoring of events. Recent research confirmed that food adverts exposure promotes consumption and that obese children in particular have heightened responsiveness to these food-promotion adverts. Although most countries do regard children as a special vulnerable group for television advertising, there are striking differences between countries in rules and regulations for food marketing to children. Only few countries have a complete ban on television advertising for younger children. But most countries (85% of 73 countries surveyed...
Correlates of fruit and vegetables

by the WHO) do have statutory regulations for food television advertising to children; regulations that define, for example, in what ways foods can be promoted at what broadcasting times. The principle underlying many regulations is that advertising may not be misleading. At the ministerial conference on counteracting obesity organised by WHO Europe, all ministers of countries in the European region signed a charter in which they recognized the importance of marketing 36.

The relative importance of liking and preferences: evidence from observational studies

To explore how important taste-preferences and liking are as population correlates of food intakes among children two recently published studies on correlates of F&V intakes, the Pro Children Study and the Fruits and Vegetables Make the Mark study are illustrative 28,37.

The Pro Children Project

A cross-sectional survey was conducted as part of the Pro Children Project in nine European countries (Austria, Belgium, Denmark, Iceland, the Netherlands, Norway, Portugal, Spain and Sweden) during October – December 2003. Schools constituted the sampling unit, and from each country random samples of at least 20 schools and a minimum of 1300 11-year old eligible children were recruited. A participation rate of 90.4% was reached in the participating schools; mean age was 11.4 years (range 8.8-13.8, SD=0.48; 79% of the children was born in 1992). The final sample sizes varied from 1,105 for the Netherlands to 2,134 for Portugal, with a total sample size of 13,305. A detailed description of the Pro Children Project, including the sampling and data collection procedure is given elsewhere 6,9. All protocols and questionnaires of the Pro Children Projects can be accessed at www.prochildren.org.

A self-report questionnaire in all applicable languages was developed to measure F&V intake, and possible determinants informed by a social-ecological model 9, a literature review 38, focus group interviews with children 39, individual interviews with parents and school staff, and thorough pre-testing as well as a rigorous translation - back translation procedure 39,40. The questionnaire included questions that were analogous for F&V intake on motivational factors such as liking and preferences, and attitudes; ability-related factors such as knowledge of recommended intake levels, self-efficacy and perceived barriers. The questionnaire also included items on opportunity-related factors related to the social-cultural environment: parental and peer modelling, active parental encouragement, parental demands to eat F&V, whether parents allow the child to eat as much F&V as they like (parental allowances), whether parents actively facilitate
F&V intake by preparing/cutting F&V (parental facilitation) and by giving their children F&V to bring to school; and related to the perceived physical environment: availability of F&V at home, at school, and at friends’ home. An overview of the items, constructs, scaling and psychometrics is reported elsewhere. Usual F&V intake was measured using a validated food-frequency questionnaire (FFQ).

Multilevel logistic regression analysis was used to investigate the associations of daily fruit (dichotomous) intake and daily vegetable intake (dichotomous) with the different motivational, ability and opportunity factors. The predictors were also dichotomized into 0 (negative or neutral, response category -2 to 0.49) or 1 (positive, response category > 0.49). Adjusted odds ratios (OR) and 98% confidence intervals (CI) were calculated for the total sample, both gender groups and all nine countries separately.

Differences in daily intake of F&V
In the total sample 43.2% of the children reported to eat fruit every day, 46.1% reported to eat vegetables every day. A significant gender difference was found for both outcome measures: 47.7% of the girls and only 38.9% of the boys reported to eat fruit daily (OR:1.44, 98% CI:1.33-1.56), while 51.8% of the girls and 40.5% of the boys reported to eat vegetables every day (OR:1.58, 98% CI:1.45-1.71). Significant differences were also found between the nine participating countries (p<0.001). For daily fruit intake, the lowest rates were found in the Nordic countries of Norway, Iceland and Sweden, while the highest proportion of children with daily fruit intake was found in Portugal. For daily vegetable intake, low rates were again found in Norway, Iceland and Spain, and the highest rates were in the Netherlands, Belgium and Portugal.

Correlates of daily F&V intakes
For daily fruit intake, motivation, ability as well as opportunity factors appeared to be of relevance. Daily fruit intake was more likely to be reported by children with a positive liking for fruit, with a preference for many different fruits and a positive attitude towards fruit intake. Furthermore, daily fruit intake was more likely among children who knew the national recommendation for fruit intake and with positive self-efficacy. In addition, four of the six social-environmental factors yielded significance. Daily fruit intake was more likely to be reported by children, who experienced positive role models, by those with parents who demand them to eat fruit every day, by children with parents who facilitate fruit intake by cutting up fruit, and by those bringing fruit to school. None of the physical environmental factors was significantly associated with likelihood of daily intake (see TABLE 2.1).
Daily vegetable intake was also related to a positive liking of the taste of vegetables, a preference for different vegetables and a positive attitude towards vegetable consumption. Knowing the national guidelines for adequate vegetable intake and a positive self-efficacy to eat vegetables were also significantly associated with daily vegetable intake. All six social-environmental factors were significantly associated with eating vegetables every day. Finally, children who frequently have available vegetables they like at their home were more likely to report daily vegetable consumption.

In country specific analyses a preference for many fruits was significant in five out of nine countries, a liking of the taste of fruit in three countries. Regarding ability-related factors, knowledge of the recommendation was significant in all countries, and in seven countries daily fruit intake was significantly associated with positive self-efficacy. Of the opportunity-related factors, modelling was significant in all countries, bringing fruit to school was significant in eight of the nine countries, and parental demand to eat fruit daily was significant in six countries.

Liking the taste of vegetables was significantly associated with daily vegetable intake in six out of nine countries, while preference for many vegetables was significant in eight countries. Among the ability-related factors, self-efficacy and knowledge of recommendations yielded significance in six and five countries respectively. Parental demand (seven countries) and modelling (five countries) were the opportunity factors that were positively associated with daily vegetable intake in a majority of countries (see TABLE 2.1).

These analyses indicate that liking and preferences are associated with daily intake of F&V among school-aged children in Europe. However, other factors related to ability and opportunity were also important with effect sizes of a similar magnitude as preferences and liking. Effect sizes were in general somewhat larger for fruit intake than for vegetable intake.
**TABLE 2.1**: Odds ratios (ORs\(^1\)) and 98% confidence intervals (CI) derived from multilevel logistic regression analyses of the Pro Children Study with daily F&V intakes as dependent variables and motivation, ability and opportunity factors as independent variables.

<table>
<thead>
<tr>
<th></th>
<th>daily Fruit intake (N=13168) OR (98% CI)</th>
<th>daily Vegetable intake (N=11905) OR (98% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motivation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liking</td>
<td>1.97 (1.52–2.55)</td>
<td>1.60 (1.41–1.80)</td>
</tr>
<tr>
<td>Preferences</td>
<td>2.09 (1.79–2.43)</td>
<td>1.46 (1.30–1.63)</td>
</tr>
<tr>
<td>Attitudes</td>
<td>1.36 (1.14–1.63)</td>
<td>1.16 (1.03–1.31)</td>
</tr>
<tr>
<td><strong>Ability</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>2.25 (2.03–2.49)</td>
<td>1.41 (1.26–1.58)</td>
</tr>
<tr>
<td>General self-efficacy</td>
<td>0.88 (0.64–1.20)</td>
<td>0.82 (0.68–1.00)</td>
</tr>
<tr>
<td>Perceived barriers(^2)</td>
<td>1.74 (1.44–2.11)</td>
<td>1.83 (1.65–2.02)</td>
</tr>
<tr>
<td><strong>Opportunity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social-environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modelling</td>
<td>1.95 (1.74–2.19)</td>
<td>1.43 (1.29–1.60)</td>
</tr>
<tr>
<td>Active parental encouragement</td>
<td>0.96 (0.85–1.08)</td>
<td>1.26 (1.12–1.41)</td>
</tr>
<tr>
<td>Demand family rule</td>
<td>1.60 (1.42–1.81)</td>
<td>1.50 (1.34–1.68)</td>
</tr>
<tr>
<td>Allow family rule</td>
<td>0.85 (0.73–1.00)</td>
<td>1.22 (1.07–1.40)</td>
</tr>
<tr>
<td>Family facilitation</td>
<td>1.34 (1.20–1.51)</td>
<td>1.16 (1.03–1.31)</td>
</tr>
<tr>
<td>Bring F&amp;V to school</td>
<td>2.75 (2.43–3.12)</td>
<td>1.99 (1.68–2.36)</td>
</tr>
<tr>
<td>Physical-environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Availability at home</td>
<td>1.22 (1.00–1.48)</td>
<td>1.27 (1.12–1.44)</td>
</tr>
<tr>
<td>Availability at school</td>
<td>1.00 (0.88–1.13)</td>
<td>1.08 (0.95–1.22)</td>
</tr>
<tr>
<td>Availability at friends house</td>
<td>1.07 (0.96–1.19)</td>
<td>1.00 (0.90–1.11)</td>
</tr>
</tbody>
</table>

\(^1\) ORs are adjusted for gender, school and country level

\(^2\) Higher scores indicated fewer perceived barriers
Gender differences and liking F&V: Fruit and Vegetables make the Marks (FVMM)

A recent comprehensive review of studies on determinants of children's F&V intake stated that gender is among the strongest determinants of adolescents’ F&V intake\(^38\); in 14 of 17 reviewed European studies girls reported to eat more F&V than boys. A study was conducted to explore why boys eat less F&V than girls and if differences in preferences for these foods explain consumption differences between boys and girls. This study was part of the FVMM intervention project including 38 randomly selected elementary schools in two Norwegian counties. The pupils within the 20 control schools were used for the study presented here\(^37\). Data from survey questionnaires completed in May 2002 and May 2005 were used for the analyses. The questionnaire surveys were completed by the pupils in the classroom in the presence of a trained project worker, within one school-lesson (45 minutes). The FVMM control group is a cohort of 896 pupils (response 84%), of which 813 and 728 respectively participated in the May 2002 (mean age 12.5) and May 2005 (mean age 15.5) surveys and also reported same gender at both surveys.

F&V intake was measured with a validated short FFQ comparable to the Pro Children Study\(^43\). Potential mediators for the gender differences in intakes were motivation-related (preferences for F&V; intention to eat 5-a-day), ability-related (self-efficacy to eat 5-a-day, knowledge about the 5-a-day recommendation) and opportunity-related (accessibility of F&V at home and modelling). These variables were assessed with one to five statements with response alternatives ranging from ‘I fully disagree’ to ‘I fully agree’, except for the knowledge question which had seven response alternatives (for details see\(^44\)). These scales have been analysed showing good reliability\(^45\).

A variable functions as a mediator when it is associated with the dependent variable (F&V intake) and with the independent variable, i.e. the potential distal determinant (gender), and when the association between the independent variable (gender) and the dependent variable (F&V intake) becomes non-significant or weakens after controlling for the potential mediator\(^46\).

All analyses conducted were different mixed models of repeated measures (i.e. both 2002 and 2005 data were included in the same analyses), all adjusting for school and time (survey), using SPSS 14. The analyses carefully tested each of the steps necessary to establish mediation. The proportions mediated by the mediators were calculated by subtracting the adjusted relationship between gender and F&V intake (e.g. \(\tau\)) from the unadjusted (\(\tau\)), and dividing the sum by the unadjusted value (i.e. \(\tau\) - \(\tau\)/\(\tau\))\(^47\).

Girls reported to eat F&V more often than boys and reported significantly more positive values for all the potential mediators (see TABLE 2.2).
### TABLE 2.2: Gender differences in F&V intake and in determinants of intake at the first measurement in 2002

<table>
<thead>
<tr>
<th>Items in scale</th>
<th>Range</th>
<th>Boys</th>
<th>Girls</th>
<th>Diff.</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>F&amp;V intake</td>
<td>4</td>
<td>0/40</td>
<td>11.9</td>
<td>14.5</td>
<td>2.6</td>
</tr>
<tr>
<td>Accessibility</td>
<td>5</td>
<td>-10/10</td>
<td>3.6</td>
<td>4.9</td>
<td>1.4</td>
</tr>
<tr>
<td>Modelling</td>
<td>4</td>
<td>-8/8</td>
<td>2.5</td>
<td>3.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Intention</td>
<td>1</td>
<td>-2/2</td>
<td>-0.1</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Preferences</td>
<td>4</td>
<td>-8/8</td>
<td>1.3</td>
<td>2.9</td>
<td>1.5</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>3</td>
<td>-14/14</td>
<td>0.1</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Knowledge</td>
<td>1</td>
<td>0/6</td>
<td>3.5</td>
<td>3.7</td>
<td>0.2</td>
</tr>
</tbody>
</table>

In the single mediation analyses all determinants mediated part of the gender differences, but only adjustment for preferences decreased the gender difference to a level below statistical significance (see TABLE 2.3). Preferences alone explained 81% of the gender difference. In the multiple mediation analyses the six mediators together explained 91% of the gender difference, with preferences contributing with the largest amount (25%). In addition, perceived accessibility contributed with 10% of the explanation (data not shown).

### TABLE 2.3: Single mediator analyses: effect of gender on F&V intake after adjusting for accessibility, modelling, intention, preferences, self-efficacy or knowledge

<table>
<thead>
<tr>
<th>Models</th>
<th>Potential mediators</th>
<th>β*</th>
<th>P-value</th>
<th>τ**</th>
<th>Gender P-value</th>
<th>Mediated (τ - τ')/τ †</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Accessibility</td>
<td>0.9</td>
<td>&lt; 0.001</td>
<td>1.3</td>
<td>&lt; 0.001</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>Modelling</td>
<td>0.8</td>
<td>&lt; 0.001</td>
<td>2.1</td>
<td>&lt; 0.001</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>Intention</td>
<td>1.8</td>
<td>&lt; 0.001</td>
<td>1.8</td>
<td>&lt; 0.001</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>Preferences</td>
<td>0.9</td>
<td>&lt; 0.001</td>
<td>0.5</td>
<td>0.19</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>Self-efficacy</td>
<td>1.1</td>
<td>&lt; 0.001</td>
<td>1.8</td>
<td>&lt; 0.001</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td>Knowledge</td>
<td>1.1</td>
<td>&lt; 0.001</td>
<td>2.3</td>
<td>&lt; 0.001</td>
<td>0.10</td>
</tr>
</tbody>
</table>

* Difference in the single potential mediators between boys and girls, while adjusting for F&V intake  
** Difference in F&V intake between boys and girls, while adjusting for single potential mediators  
† Proportion of the gender difference in F&V intake mediated by the respectively factors
DISCUSSION

F&V intakes among schoolchildren are associated with preferences and liking, and the differences in intakes between girls and boys is strongly mediated by preferences. However, preferences are certainly not the only potential determinant of intakes. Ability and opportunity related factors such as knowledge, self-efficacy, parental influences and accessibility of F&V are also associated with daily intake. These results were consistent across different countries in Europe. Accessibility of F&V further mediates gender differences in intakes and recent research indicates that socio-economic differences in schoolchildren’s F&V intakes are more strongly related to accessibility differences than preference differences.

The fact that liking and preferences were related to likelihood of daily intake of both F&V has been found in earlier studies and confirms the importance of these motivation-related factors among children. Repeated exposure to many different kinds of F&V at early age might be a good strategy to improve liking and increased intakes have been found to be associated with increased liking. Especially parents can promote preferences for F&V in such a way. The results indeed confirm earlier studies that show that parental social environmental factors are important for dietary behaviours among school-aged children. In line with previous research, perceived modelling was a predictor of daily F&V intake. Such social learning strategies are also important for learning to like the taste of F&V. Next to this rather ‘passive’ influence of parental modelling, more active parental encouragement and facilitation was also associated with daily intakes.

Knowledge of the prevailing recommendations was positively related to daily F&V intake which indicates that teaching these recommendations in primary schools may help to promote daily intake. School and family influences are very important to influence taste preferences and liking of F&V and therefore these are ideal settings for interventions. Positive self-efficacy was another ability-related factor associated with daily F&V intake. The literature is inconsistent about the relationship between self-efficacy and F&V intake, probably due to different possible operationalisations of the self-efficacy construct. Self-efficacy can probably be improved by making F&V as available and accessible as possible and thus improve opportunity factors, and the Pro Children Study indicates that bringing F&V to school is a good strategy to encourage daily F&V intakes.

In the present study only home availability appeared to be a significant physical environmental correlate of daily vegetable consumption but not of daily fruit intake, although the association was close to reaching statistical significance. Earlier studies
consistently showed positive associations between availability and F&V intakes
51,52,55,57,59,60.

Bere et al. confirmed that gender is a strong correlate of F&V intake and additionally showed that the gender difference in F&V intake could be explained by differences in preferences and accessibility between boys and girls. That perceived accessibility is higher among girls might be due to the fact that parents raise their daughters in a different way than they raise their sons where foods are concerned, which is also illustrated by observations in the Pro Children Study: parents of daughters were more involved in the intervention and participated more often in parental activities than parents of boys 61. That opportunities for girls to eat F&V are better than for boys, might also result in higher motivational factors such as taste preferences. However, from this cross sectional study we can not conclude on causal relationships between determinants.

The two observational studies and the literature indicate that a wide range of determinants are important in children’s F&V consumption. However, which determinants of F&V are exactly the most important ones is still difficult to answer because determinants are interrelated and from a complex pattern.

CONCLUSION

The present paper showed that the framework proposed by Rothschild can help to categorize important determinants of F&V intake and dietary intake in general. Furthermore, we showed that motivation factors, such as preferences, are among the most important determinants of F&V intake among adolescents and that differences in preferences could also explain discrepancies in F&V intake levels between boys and girls.

Moreover, opportunities, such as availability and accessibility of F&V, are important as well and more research is needed to assess potential moderating roles of availability and/or motivational factors.
**REFERENCE LIST**


Correlates of fruit and vegetables


Are positive changes in potential determinants associated with increased fruit and vegetable intakes among primary schoolchildren? Results of two intervention studies in the Netherlands: the Schoolgruiten Project and the Pro Children Study

Paper published as:
ABSTRACT

Background: To investigate if positive changes or maintenance of high scores on potential behavioural determinants of fruit and vegetable (F&V) intake are associated with increased or maintenance of favorable levels of F&V intake frequency in the same time lapse or later in time. Data were used from two intervention studies in the Netherlands: the Schoolgruiten Project and the Pro Children Study.

Methods: A design with baseline and two follow-up measurements. 344 children of the Dutch Schoolgruiten Project and 258 children of the Pro Children Study completed questionnaires, including questions on general demographics, usual F&V intake frequency, important potential determinants of F&V intake, such as taste preferences of F&V, availability of F&V, knowledge of recommended intake levels of F&V, self-efficacy for eating F&V, and parental influences for eating F&V. Three different associations between changes in determinants of F&V intake and changes in F&V intake frequency were assessed by multilevel multinomial regression analyses.

Results: Results of one of the investigated associations indicated that in both studies behaviour change (increase in F&V intake frequency) was preceded by changes in the following variables; liking of fruit, parental facilitation of vegetables, family rules for eating vegetables and availability at home of vegetables. Furthermore, changes in F&V intake frequency preceded changes in liking of F&V later in time.

Conclusion: In accordance with behaviour change theories, the present study provides some evidence that behaviour change was preceded by changes in certain potential determinants of F&V intake. Potential determinants of F&V intake that appear to be important to induce behaviour change were liking of fruit, parental facilitation of eating vegetables, family rules for eating vegetables and availability at home of vegetables. Some evidence was also found that behaviour changes may precede changes in presumed determinants of F&V intake, such as liking of F&V.
INTRODUCTION

Ample intake of fruit and vegetables (F&V) is part of dietary recommendations in many countries. However, among schoolchildren across Europe, the reported intake of F&V is lower than recommended. The Dutch recommendation for F&V intake for 10-12-year-old children is to eat at least two pieces of fruit (about 200-250 grams) and 150-200 grams vegetables per day.

According to health behaviour change theories such as the Social Cognitive Theory and the Theory of Planned Behaviour, increasing F&V intake can be induced by changes in presumed behavioural determinants, such as attitudes, social influences and self-efficacy or perceived behavioural control. Furthermore, studies on determinants of F&V intake among children showed that taste preference, availability, parental intake levels, and knowledge of recommended intake levels are of additional potential importance as mediators or determinants of behaviour and behaviour change.

However, the majority of these studies applied cross-sectional designs, which does not allow concluding upon causal relationships between potential determinants and F&V intake. It might as well be that changes in F&V intake precede changes in presumed determinants. For instance, increased exposure to F&V can influence taste preferences.

Other studies conducted mediation analyses to study whether an intervention effect could be explained by presumed mediating variables (which are often the most important potential determinants of the behaviour in question). These mediation analyses aim at explaining the effect of an intervention and often study changes in behaviour and changes in mediating variables occurring in the same time period. Therefore, strictly speaking, these studies cannot draw conclusions regarding the direction of the relationship between the potential determinants or mediators and behaviour or behaviour change. Longitudinal studies are therefore required to better understand the relationships between potential important determinants of F&V intake and F&V intake among children.

Data of the Dutch Pro Children Study and the Schoolgruiten Project provide the opportunity to study changes in F&V intake frequency and potential determinants measured at three different time points (see FIGURE 3.1). Therefore, the aim of the present study was to investigate whether positive changes in or maintaining of high scores on the presumed important determinants of F&V intake in the first time lapse (period between baseline and first follow-up) were associated with positive changes.
or maintenance of favorable levels in F&V intake frequency in the same time lapse (association A in FIGURE 3.1) and with positive changes or maintenance of favorable levels in F&V intake frequency later in time (association B in FIGURE 3.1). Furthermore, we examined whether positive changes or maintenance of favorable levels in F&V intake frequency were associated with positive changes in or maintenance of high scores on the variables that were identified as potentially important determinants of F&V intakes in earlier studies, later in time (association C in FIGURE 3.1). These analyses were conducted separately for the Dutch Schoolgruiten Project and the Dutch Pro Children Study. We hypothesized that those who reported positive changes or kept a favorable score in a presumed determinant of F&V, also reported positive changes or kept favorable levels of F&V intake frequency (in the same time period or later in time).

METHODS

Description of both projects
The Pro Children Study is a cross-European study on F&V intake among primary schoolchildren (age; 10-11 years old at baseline) 22. For the present analyses, we only included the Dutch intervention part of the Pro Children Study, which was implemented in Rotterdam, one of the major cities in the Netherlands. The Pro Children Study addressed a wide range of important determinants of F&V intake based on a previously published theoretical framework 22. This theoretical framework recognizes the role of the physical environment, such as the availability and accessibility of foods 19, as well as social environmental factors 9. Among children, the role of family environment is of specific importance. Furthermore, children spend a considerable amount of their time at school, and the school environment may also importantly influence nutrition and physical activity behaviours 13. The Schoolgruiten Project is also a Dutch intervention study among primary schoolchildren (age; 9-10 years old at baseline). This project was implemented in two intervention cities in the Netherlands: in The Hague, one of the major cities in the west part of the Netherlands, and in Almelo, a medium sized city in the east part. Similar to the Pro Children Study, the main strategy within the Schoolgruiten Project was targeting taste preferences, availability and accessibility. For the present study, we only included children from the intervention schools, since these children are more likely to show changes in potential determinants of F&V intake, as a consequence of the intervention activities 20,21. The data was used as observational longitudinal cohort data.
Design of the studies

The baseline survey of the Pro Children Study was conducted in September 2003. First follow-up was performed nine months after the baseline measurement (May 2004) and second follow-up was performed exactly one year after first follow-up (May 2005). The baseline survey of the Schoolgruiten Project was conducted in The Hague in the spring of 2003 and in Almelo in the autumn of 2003. First follow-up was conducted in both cities exactly one year later and second follow-up was conducted exactly two years later.

During the intervention period the intervention schools of the Pro Children Study were provided with a piece of fruit or ready-to-eat vegetables (cherry tomatoes, baby carrots) for free during a fruit break twice a week. In addition, a classroom curriculum was implemented, which consisted of worksheets and a web-based computer tailored feedback tool. Furthermore, parents were encouraged to be involved in the project by means of their children’s homework assignments, parental newsletters, and a parent version of the web-based computer tailored tool that enabled them to get personalized feedback on their own F&V intake levels.

The children of the intervention schools of the Schoolgruiten Project received also a piece of fruit or ready-to-eat vegetables for free during a fruit break twice a week. All children ate the piece of fruit or vegetable in their own classroom. Apart from increasing availability and accessibility, this F&V scheme was also supposed to increase the children’s exposure to F&V, which in turn can influence the children’s taste preferences.

Additionally, a school curriculum, developed and carefully pre-tested by the Netherlands Nutrition Center Foundation, aiming at increasing knowledge and skills related to F&V intake was offered to the intervention schools. The intervention schools were not obliged to use this curriculum, but they were strongly encouraged to do so.

Schoolgruiten Project was approved by the Netherlands Organization for Health Research and Development (Zon Mw) Program for Prevention and by The World Cancer Research Fund. The Pro Children Study was approved by the medical ethical committee of the Erasmus University Medical Center. For the Pro Children Study, the parents provided written informed consent for themselves and their child. For the Schoolgruiten Project the informed consent was authorized by a legal representative (the school board).
Recruitment of the schools and study sample

For the Pro Children Study, 76 primary schools were initially sampled of which 24 schools with 735 eligible students (both intervention and control schools) agreed to participate in the total study. These 24 schools were randomly assigned to an intervention (12 schools) or a control group (12 schools).

As mentioned before, only the data of the twelve intervention schools are included in the present analyses. At the start of the study, 410 pupils were eligible for participation. Because of absence at the day of data collection or because of lack of informed consent (n=41), 369 children actively participated at baseline. Since one of the study purposes was to investigate whether positive changes in or maintenance of high scores on the potential determinants of F&V intake were associated with positive changes or maintenance of favorable levels in F&V intake frequency later in time, only the children that had valid data on all three measurements were included. A total of 258 children were finally included for analyses.

Children with complete self-reported data on F&V intake frequency at baseline but not at first or at second follow-up were considered as dropouts. Dropout was due to children who moved to other places or schools, did not graduate to the next grade, were absent on the day of administration at first or at second follow-up (n=87), or had missing F&V reports at one of the three measurements moments (n=24).

The Schoolgruiten Project included 31 intervention schools. All fourth grades from primary schools in the intervention cities were eligible for participation and schools were randomly approached by phone, and invited to participate in this survey. All children (n=693) who were present on the day of administration completed the questionnaires. Two schools were not willing to participate anymore at first follow-up, resulting in fewer children (n=613) at first follow-up. Six schools were not willing to participate anymore at second follow-up, again reducing the number of children (n=504) in the sample. Only the children that completed all questions on fruit intake frequency or all questions on vegetable intake at all three measurements were included in the analyses. A total of 344 children were included in the analyses.

Again, children with valid self-reported data on fruit and/or vegetable intake frequency at baseline but not at first or at second follow-up were considered as dropouts. Dropout was due to the loss of eight schools (n=146), because children moved to other places or schools, did not graduate to the next grade, were absent on the day of administration at first or at second follow-up (n=190), or had missing F&V reports at one of the three measurements moments (n=13).

Since some children had missing data for some of the variables, the number differed slightly between different analyses, as indicated in the relevant tables.
Procedure
In both studies schoolchildren received questionnaires, which they completed during one-school hour. Questionnaire administration was according to a written protocol. In the Schoolgruiten Project, questionnaire administration was led by the teacher, while in the Pro Children Study children completed the questionnaires in the presence of a project worker. Children of both studies received another questionnaire to take home for completion by one of their parents. Responses were treated anonymously and confidential. All data of the Pro Children Study were entered and cleaned in the national centres according to a standardized protocol. All national data sets were pooled and further data processing and quality control was carried out in the Data Management Center at the University of Vienna (for more information on protocols and data management, as well as the questionnaires visit the website of Pro Children).

Questionnaires
For both projects two questionnaires were developed, a parental and a child version. In the Pro Children Study the questionnaires were pilot-tested for validity and reliability. Specific information on the development, reliability and validity of the questionnaires has been published previously. Briefly, correlations between the frequency questionnaire answers regarding total F&V intake and the reference method (a 7-day food record) varied between 0.38 and 0.53. Correlations for total F&V intake between the test and the re-test measurement varied between 0.47 and 0.76. The internal consistency of the scales and the test-retest reliability and predictive validity of the behaviour theory-based constructs measuring the personal, social and environmental correlates of F&V intake of the Pro Children questionnaire was assessed in five European countries in 10-11-year-old children. The test-retest reliability was good (intra-class correlation coefficient (ICC > 0.60) for 12 out of the 15 fruit constructs and also 12 out of the 15 vegetable constructs. Acceptable ICCs, ranging between 0.50 and 0.59, were found for the remaining constructs. Cronbach’s α values were moderate to high (range 0.52 to 0.89) with the exception of the general self-efficacy scale, which had a value below 0.50 for both fruit (α=0.42) and vegetables (α=0.49). Spearman correlations with intake ranged between -0.16 and 0.54 for personal factors and between 0.05 and 0.38 for environmental factors. Compared with other studies, predictive validity can be considered as moderate.

The child and parent questionnaires developed for the Schoolgruiten Project were based on the two Pro Children questionnaires. A more detailed description of the questions and answer alternatives of the Schoolgruiten questionnaire has been published previously.
Chapter 3

For both studies, child reported F&V intake frequency and their potential determinants were used. For both studies, general demographic information, like information on the parent’s country of birth, level of education and child’s age, was retrieved from the parent’s questionnaire.

**F&V intake frequency**

Both the Pro Children Study and the Schoolgruiten Project used food frequency questions to assess usual frequency of intake of F&V. This measure is very useful and often used in studies on correlates, predictors or determinants of food intake. This measure assesses individual usual intake frequency. More specific measures such as 24H recall methods do not provide valid assessments of usual intake for individuals.

In the Pro Children Study, usual daily intake frequency of F&V was assessed with different food frequency questions. Frequency of fruit intake was assessed by one question: “How often do you usually eat fresh fruit”. Frequency of salad and grated, other raw and cooked vegetables intake was measured separately by three questions. All four questions had eight response alternatives ranging from “never” (0) to “every day, more than twice per day” (7). Mean intake in grams per day was calculated by the sum of frequency of intake of salad/grated, raw and cooked vegetables multiplied by a standard portion size (60 gram for cooked vegetables, 40 gram for salad, and 50 gram for raw vegetables). This questionnaire was validated by a 7-day food record; the first day was a weighed record and the following 6 days were estimated records.

In the Schoolgruiten Project, we calculated average daily fruit intake (in pieces per day) as the number of days when fruit was eaten multiplied by the number of pieces eaten per day, divided by seven. We calculated average daily vegetable intake (in grams per day) as the number of days when vegetables were eaten multiplied by the amount of vegetables shown on the indicated photographs, divided by seven. The photographs were based on the validated Dutch EPIC Food Frequency Questionnaire. The pictures represent a combination of standard portions, four plates with standard portions of boiled vegetables, and four plates with standard portions of composite dishes. A composite dish contains at average a third of mixed vegetables. For calculations we combined these portion sizes by adding up these amounts and dividing by two. For calculation of raw vegetable consumption, 35 gram was considered a standard child portion size. This is half of the standard adult portion size (70 gram) according to the Netherlands Nutrition Center Foundation. Total frequency of vegetable intake was the sum of boiled and raw vegetables. A more detailed description of the questions and answer alternatives has been published elsewhere.
Potential determinants of F&V intake

In the Pro Children Study a wide range of potential personal, social and environmental determinants related to F&V intake were measured. For the present study we made a selection of variables, based on what was measured in the Pro Children Study and in Schoolgruiten, based on a literature review, and on results of previous cross-sectional multivariate associations reported for the Pro Children Study. In these studies the authors concluded that liking of F&V, knowledge of recommended intake levels of F&V, self-efficacy for eating F&V, availability of F&V at home, and parental influences were the most important potential determinants of F&V intake. Therefore, we included these variables in the present study.

All these potential determinants were measured for both fruit and vegetable intakes, separately. All factors, except knowledge of recommended intake levels, were assessed using a 5-point Likert scale: fully disagree (-2) to fully agree (+2). To assess knowledge of recommended intake levels, children were asked on an eight-point scale how much fruit or vegetables they should eat every day. Response options ranged from “no fruit or no vegetables” (0) to “5 pieces or portions per day or more” (7). This was subsequently recoded into a dichotomous variable (less than the recommended intake levels versus the recommended intake levels or more).

Also in the Schoolgruiten Project different potential determinants of fruit intake were measured. Based on the same arguments as described before, we included the following determinants in the current study: liking and knowledge of recommended intake levels, both for fruit and for vegetable intakes, and accessibility and availability at home, only for fruit intake. All these determinants were assessed with questions similar to those used in the Pro Children Study.

General demographic information

For both studies, distinctions were made between children of Dutch, non-Western, and non-Dutch Western ethnicity (Europe (excluding Turkey), North America, Oceania, Indonesia or Japan), according to the definition of the Dutch Institute of Statistics. When at least one of the parents was born in a non-Western country the child was considered as of non-Western ethnicity.

Family educational level was used as a measure of socio-economic position. For both studies, parents responded to questions regarding their educational level. Educational level was treated as a categorical variable, using three categories based on the highest educational level of one of the parents (primary school or pre-vocational training=low; high school or medium level vocational training=medium; high level vocational training, college or university training=high).
Statistical analyses

Means, standard deviations and percentages were calculated to describe the key variables.

Selective dropout was assessed by logistic regression analyses with gender, parental educational level, ethnicity, region of residence of the children (only for Schoolgruiten study) (categorical variables), and intake frequency of fruit or vegetable at baseline (continuous variables) as independent variables, and dropout (1=yes, 0=no) as the dependent variable.

As suggested by Twisk and Proper, associations between changes in potential determinants and changes in F&V intake frequency were assessed by means of multilevel multinomial logistic regression analyses. This method takes into account that change can either be an increase or a decrease, or no change (stable). Furthermore, it accounts for the phenomenon that children with high intake levels at baseline, are less likely to increase their intake, and are more likely to report less extreme values at follow-up (i.e. regression to the mean). For these analyses newly constructed categorical dependent variables were created, describing the change in a specific determinant. The categories were: the ‘decreasers’ group (= the reference group [0], the ‘stable low’ (SL) group [1] and the ‘stable high’ (SH) group, and the ‘increasers’ group [2]. The latter two groups were merged together because both outcomes were considered positive outcomes.

When cells for the multinomial logistic regression analyses include a small number, no reliable ORs can be estimated. Five percent of the total sample or less was considered as a small number and in that case three categories were merged into two categories to solve this problem.

To describe the positive change or maintenance of favorable levels in fruit or vegetable intake frequency in the first and second time lapse, we used a relative measure, to overcome the phenomenon that children of this study tended to overestimate their FV intake frequency at baseline, as published previously. The phenomenon of over-reporting by younger Dutch children was also observed by Reinaerts et al. For the relative measure, we constructed quartiles of intake frequency at all time points and analyzed whether children changed their relative position. This resulted in a dichotomous variable: ‘the SL’ and ‘the decreasers’ [0], (negative outcome) and ‘the SH’ and ‘the increasers’ [1] (positive outcome). All children who complied with the Dutch daily recommendations for fruit or vegetables intake were also assigned to the ‘SH/increasers’ group, because these outcomes were still a positive outcome.

A multilevel analysis was used to take into account the nested design of the study (pupils were nested within schools). Analyses were further adjusted for children’s age, gender, parental education level, ethnicity, and region of residence (only for the Schoolgruiten study).
According to the aims of the present study, we performed a series of analyses (see FIGURE 3.1) assessing: A) if positive changes or maintenance of favourable levels of F&V intake frequency in the first time lapse, was associated with higher odds of having positively changed or kept high scores of the specific potential determinants in the same time lapse (association A in FIGURE 3.1); B) if positive change of maintenance of favorable levels of F&V intake frequency later in time was associated with higher odds of having positively changed or kept high scores of the specific potential determinants in the previous time lapse (association B in FIGURE 3.1); C) if positive changes or keeping high scores of the specific potential determinants later in time were associated with higher odds of having increased F&V intake frequency in the previous time lapse (association C in FIGURE 3.1).

Associations were estimated by odds ratios (ORs), which reflect the odds for being in the specific category (for change in determinant) compared to being in the reference category (= decreasers group) for the group that increased or maintained favorable levels of F&V intake frequency.

The data analyses were performed using SPSS 11.0 (SPSS Inc., Chicago, IL, USA, 1999). The multi-level analyses were conducted using MLwiN software (Version 2.01). The significance level was set at p < 0.05.
RESULTS

Dropout
There was no selective dropout in the Pro Children Study. For the Schoolgruiten Project selective dropout was found for boys (OR=1.83, 95% CI 1.25 - 2.68), and for those residing in Almelo, the eastern region (OR=2.47, 95% CI 1.62 - 3.78), due to the loss of eight schools in this region.

Characteristics
Slightly more girls than boys participated in both studies and the majority of the children were from non-Western ethnicity in the Schoolgruiten Project (TABLE 3.1). At baseline, the age of all children of both studies ranged between 8.5 - 12.1 years.

TABLE 3.1: Characteristics of the children of the intervention groups of the Schoolgruiten Project and the Pro Children Study at baseline

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>SCHOOLGRUITEN PROJECT</th>
<th>PRO CHILDREN STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of the children, years</td>
<td>344 (10.0 (0.6))</td>
<td>255 (10.7 (0.5))</td>
</tr>
<tr>
<td>Gender</td>
<td>Boys 42.7, Girls 57.3</td>
<td>Boys 40.3, Girls 59.7</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>Native Dutch children 38.7, Children of Western ethnicity 5.2, Children of non-Western ethnicity 56.1</td>
<td>Native Dutch children 48.9, Children of Western ethnicity 5.2, Children of non-Western ethnicity 5.0</td>
</tr>
<tr>
<td>Educational level of the parents</td>
<td>Low 35.9, Moderate 35.9, High 28.2</td>
<td>Low 43.5, Moderate 27.8, High 28.7</td>
</tr>
</tbody>
</table>

F&V intake frequency
TABLE 3.2 shows the observed mean values for the intake frequency of F&V at baseline, at first and at second follow-up for the children of both studies. The table also shows the number of children that increased or kept their relative high intake levels based on quartiles of intake levels. The cut-off points of the quartiles of the F&V intakes frequency for both studies are provided in TABLE 3.3.
TABLE 3.2: F&V intakes frequency at baseline, at first and at second follow-up, separately for the children of the Schoolgruiten Project and for the children of the Pro Children Study

<table>
<thead>
<tr>
<th>F&amp;V Intakes</th>
<th>N</th>
<th>Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Baseline</td>
</tr>
<tr>
<td>SCHOOLGRUITEN PROJECT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reports on fruit intake frequency (pieces per day) (Mean (SD))</td>
<td>327</td>
<td>1.74 (1.12)</td>
</tr>
<tr>
<td>Number (%) of increasers / stable high fruit intake frequency</td>
<td>327</td>
<td>-</td>
</tr>
<tr>
<td>Reports on vegetable intake frequency (gram per day) (Mean (SD))</td>
<td>291</td>
<td>113.3 (60.3)</td>
</tr>
<tr>
<td>Number (%) of increasers / stable high vegetable intake frequency</td>
<td>291</td>
<td>-</td>
</tr>
<tr>
<td>PRO CHILDREN STUDY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reports on fruit intake frequency (pieces per day) (Mean (SD))</td>
<td>258</td>
<td>1.16 (0.93)</td>
</tr>
<tr>
<td>Number (%) of increasers / stable high fruit intake frequency</td>
<td>258</td>
<td>-</td>
</tr>
<tr>
<td>Reports on vegetable intake frequency (gram per day) (Mean (SD))</td>
<td>258</td>
<td>80.7 (64.7)</td>
</tr>
<tr>
<td>Number (%) of increasers / stable high vegetable intake frequency</td>
<td>258</td>
<td>-</td>
</tr>
</tbody>
</table>

1 Based on the relative measure of F&V intake frequency (quartiles, see TABLE 3.3)
TABLE 3.3: Cut-off points of the quartiles of the F&V intakes frequency, at baseline, at first and at second follow-up, separately for the children of the Schoolgruiten Project and the Pro Children Study

<table>
<thead>
<tr>
<th></th>
<th>First quartile</th>
<th>Second quartile</th>
<th>Third quartile</th>
<th>Fourth quartile</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SCHOOLGRUITEN PROJECT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reports on fruit intake frequency (pieces per day), at baseline</td>
<td>0 – 0.86</td>
<td>0.87 – 1.43</td>
<td>1.44 – 2.14</td>
<td>2.15 – 4.00</td>
</tr>
<tr>
<td>Reports on fruit intake frequency (pieces per day), at first follow-up</td>
<td>0 – 0.86</td>
<td>0.87 – 1.43</td>
<td>1.44 – 2.00</td>
<td>2.01 – 4.00</td>
</tr>
<tr>
<td>Reports on fruit intake frequency (pieces per day), at second follow-up</td>
<td>0 – 1.00</td>
<td>1.01 – 1.43</td>
<td>1.44 – 2.00</td>
<td>2.01 – 4.00</td>
</tr>
<tr>
<td>Reports on vegetable intake frequency (gram per day), at baseline</td>
<td>0 – 71.0</td>
<td>71.1 – 100.3</td>
<td>100.4 – 149.8</td>
<td>149.9 – 288.0</td>
</tr>
<tr>
<td>Reports on vegetable intake frequency (gram per day), at first follow-up</td>
<td>19.1 – 71.0</td>
<td>71.1 – 100.3</td>
<td>100.4 – 141.5</td>
<td>141.6 – 288.0</td>
</tr>
<tr>
<td>Reports on vegetable intake frequency (gram per day), at second follow-up</td>
<td>17.9 – 71.0</td>
<td>71.1 – 96.0</td>
<td>96.1 – 121.5</td>
<td>121.6 – 288.0</td>
</tr>
<tr>
<td><strong>PRO CHILDREN STUDY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reports on fruit intake frequency (pieces per day), at baseline</td>
<td>0 – 0.43</td>
<td>0.44 – 1.00</td>
<td>1.01 – 2.00</td>
<td>2.01 – 3.00</td>
</tr>
<tr>
<td>Reports on fruit intake frequency (pieces per day), at first follow-up</td>
<td>0 – 0.43</td>
<td>0.44 – 0.79</td>
<td>0.80 – 2.00</td>
<td>2.01 – 3.00</td>
</tr>
<tr>
<td>Reports on fruit intake frequency (pieces per day), at second follow-up</td>
<td>0 – 0.43</td>
<td>0.44 – 1.00</td>
<td>1.01 – 2.00</td>
<td>2.01 – 3.00</td>
</tr>
<tr>
<td>Reports on vegetable intake frequency (gram per day), at baseline</td>
<td>0 – 39.6</td>
<td>39.7 – 68.9</td>
<td>69.0 – 101.0</td>
<td>101.1 – 400.0</td>
</tr>
<tr>
<td>Reports on vegetable intake frequency (gram per day), at first follow-up</td>
<td>0 – 49.6</td>
<td>49.7 – 75.7</td>
<td>75.8 – 112.8</td>
<td>112.9 – 301.8</td>
</tr>
<tr>
<td>Reports on vegetable intake frequency (gram per day), at second follow-up</td>
<td>0 – 46.5</td>
<td>46.6 – 64.2</td>
<td>64.3 – 99.9</td>
<td>100.0 – 450.0</td>
</tr>
</tbody>
</table>
Analyses of relation A (see FIGURE 3.1)
The children who increased or kept their relatively high fruit intake frequency in the first time lapse were more likely to have increased their liking of fruit and increased their perceptions of availability at home of fruit in the same time lapse. We found this association for both studies (see TABLE 3.4). We found this association in the Pro Children Study also for general self-efficacy for eating fruit, parental active encouragement to eat fruit, and the family rule demanding the child to eat fruit.
The children of the Pro Children Study who increased or maintained their relatively high vegetable intake frequency in the first time lapse were more likely to report increased levels of modelling behaviour by friends and parents for eating vegetables, parental active encouragement to eat vegetables, parental facilitation of vegetables, and the family rule demanding the child to eat vegetables, in the same time lapse (see TABLE 3.4). For the Schoolgruiten Project we found a significant association between positive changes or maintained relatively high levels of vegetable intake frequency and liking of vegetables (see TABLE 3.4).

Analyses of relation B (see FIGURE 3.1)
The children who increased or maintained their relatively high fruit intake frequency later in time were more likely to have increased their liking of fruit in the previous time lapse. We found this association for both studies (see TABLE 3.4). For vegetable intake frequency in the Pro Children Study, children were more likely to report positive changes or maintained their relatively high scores in the social and physical environmental factors in the previous time lapse: parental facilitation of vegetables, family rules of eating vegetables (demanding and allowing) and availability at home of vegetables (see TABLE 3.4).

Analyses of relation C (see FIGURE 3.1)
We found significant associations between increased or stable high fruit intake frequency in the first time lapse and increased knowledge of recommended intake levels of fruit intake later in time in the Pro Children Study. For the Schoolgruiten Project we found significant associations of increased or stable high intakes of F&V frequency in the first time lapse and increased or maintenance of high scores on liking of both F&V intake later in time.
**Table 3.4:** Likelihood of change in determinants in the first time lapse and change in F&V intake frequency in the same time lapse, and later in time estimated with multinomial multilevel analyses, separately for children of the Schoolgruiten Project and the Pro Children Study.

<table>
<thead>
<tr>
<th>SCHOOLGRUITEN PROJECT</th>
<th>Stable high / increase in fruit intake frequency in first time lapse</th>
<th>Stable high / increase in vegetable intake frequency in first time lapse</th>
<th>Stable high / increase in fruit intake frequency in second time lapse</th>
<th>Stable high / increase in vegetable intake frequency in second time lapse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in determinants of F&amp;V intake in first time lapse</td>
<td>N</td>
<td>OR</td>
<td>95% CI</td>
<td>N</td>
</tr>
<tr>
<td>Liking</td>
<td>Decreased (2)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Stable low (1) (decreased (1))</td>
<td>68</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Stable high – increased (0)</td>
<td>220</td>
<td>2.89</td>
<td>1.64 – 5.09</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Decreased / stable low (1)</td>
<td>91</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Stable high – increased (0)</td>
<td>172</td>
<td>1.64</td>
<td>0.97 – 2.79</td>
</tr>
<tr>
<td>Taking fruit without asking</td>
<td>Decreased / stable low (1)</td>
<td>57</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Stable high – increased (0)</td>
<td>225</td>
<td>1.18</td>
<td>0.63 – 2.18</td>
</tr>
<tr>
<td>Availability at home</td>
<td>Decreased / stable low (1)</td>
<td>55</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Stable high – increased (0)</td>
<td>230</td>
<td>2.97</td>
<td>1.61 – 5.46</td>
</tr>
</tbody>
</table>
### PRO CHILDREN STUDY

#### Change in determinants of F&V intake in first time lapse

<table>
<thead>
<tr>
<th></th>
<th>Stable high / increase in fruit intake frequency in first time lapse</th>
<th>Stable high / increase in vegetable intake frequency in first time lapse</th>
<th>Stable high / increase in fruit intake frequency in second time lapse</th>
<th>Stable high / increase in vegetable intake frequency in second time lapse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>OR</td>
<td>95% CI</td>
<td>N</td>
</tr>
<tr>
<td>Liking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased / stable low (1)</td>
<td>72</td>
<td>1.00</td>
<td>-</td>
<td>117</td>
</tr>
<tr>
<td>Stable high – increased (0)</td>
<td>118</td>
<td>3.39</td>
<td>1.80 – 6.37</td>
<td>85</td>
</tr>
<tr>
<td>Knowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased (2)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Stable low (1) (decreased (1))</td>
<td>47</td>
<td>1.00</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>Stable high – increased (0)</td>
<td>166</td>
<td>1.79</td>
<td>0.91 – 3.52</td>
<td>67</td>
</tr>
<tr>
<td>General self-efficacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased / stable low (1)</td>
<td>63</td>
<td>1.00</td>
<td>-</td>
<td>85</td>
</tr>
<tr>
<td>Stable high – increased (0)</td>
<td>139</td>
<td>2.19</td>
<td>1.17 – 4.10</td>
<td>118</td>
</tr>
<tr>
<td>Modelling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased / stable low (1)</td>
<td>110</td>
<td>1.00</td>
<td>-</td>
<td>95</td>
</tr>
<tr>
<td>Stable high – increased (0)</td>
<td>80</td>
<td>1.16</td>
<td>0.64 – 2.13</td>
<td>101</td>
</tr>
<tr>
<td>Active encourage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased / stable low (1)</td>
<td>100</td>
<td>1.00</td>
<td>-</td>
<td>86</td>
</tr>
<tr>
<td>Stable high – increased (0)</td>
<td>103</td>
<td>1.78</td>
<td>1.00 – 3.16</td>
<td>122</td>
</tr>
<tr>
<td>Facilitation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased (2)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Stable low (1) (decreased (1))</td>
<td>54</td>
<td>0.84</td>
<td>0.44 – 1.60</td>
<td>66</td>
</tr>
<tr>
<td>Stable high – increased (0)</td>
<td>77</td>
<td>1.64</td>
<td>0.92 – 2.94</td>
<td>64</td>
</tr>
<tr>
<td>Demand family rule</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased (2)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Stable low (1) (decreased (1))</td>
<td>52</td>
<td>0.64</td>
<td>0.33 – 1.24</td>
<td>77</td>
</tr>
<tr>
<td>Stable high – increased (0)</td>
<td>106</td>
<td>2.63</td>
<td>1.48 – 4.68</td>
<td>138</td>
</tr>
<tr>
<td>Allow family rule</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased / stable low (1)</td>
<td>31</td>
<td>1.00</td>
<td>-</td>
<td>64</td>
</tr>
<tr>
<td>Stable high – increased (0)</td>
<td>180</td>
<td>0.70</td>
<td>0.32 – 1.54</td>
<td>150</td>
</tr>
<tr>
<td>Availability at home</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decreased / stable low (1)</td>
<td>75</td>
<td>1.00</td>
<td>-</td>
<td>80</td>
</tr>
<tr>
<td>Stable high – increased (0)</td>
<td>112</td>
<td>2.38</td>
<td>1.29 – 4.40</td>
<td>115</td>
</tr>
</tbody>
</table>

OR – odds ratio for being in the specific category (for change in determinant) compared to being in the reference category (= decreasers group) for the group that increased or maintained favorable levels of F&V intake frequency. CI; confidence interval. Analyses are adjusted for children’s age, gender, region of residence of the children (only in the Schoolgruiten Study), and parental educational level.
DISCUSSION

The present study aimed to assess whether positive changes in or maintenance of high scores on presumed determinants of F&V intake were associated with positive changes or maintenance of favorable levels of F&V intake frequency in the same time lapse or later in time. Results indicated that behaviour change was preceded by changes (or maintenance of high scores) in (some) presumed important determinants of F&V intake. Changes in these variables were even more often associated with positive changes or maintenance of favorable levels of F&V frequency intake in the same time lapse. This might be caused by the fact that most changes in determinants and intakes occurred in the first year, at least in the Pro Children Study \(^{21}\), as a result of the fact that the intervention was most intensive in the first year. This results in more variation in the change in determinants and F&V intake frequency in the first time lapse than later in time, making it easier to detect associations in the first time lapse. However, the analyses within the same time lapse do not allow drawing conclusions on the direction of the relationships. The analyses including different time lapses provided this information, however, very few significant associations were observed. Furthermore, the time intervals between the different measurements might have been too long to detect whether changes in determinants precede changes in F&V intake frequency or visa versa. Therefore, more longitudinal research with shorter time intervals between the repeated measurements is needed.

Presumed determinants that predicted behaviour change (=increase intake of F&V frequency) were liking of F&V, facilitation by the parents of F&V, family rules for eating F&V and availability at home of F&V. This is in accordance with social ecological behaviour change theories \(^{35}\) and the rationale for both intervention studies \(^{22}\). Exposure to F&V by means of the F&V scheme and taste testing were meant to influence taste preferences and subsequently to increase F&V intake frequency. Repeated exposure is an important determinant of taste preferences \(^{15}\). The family component was included to advise parents on how they could support and facilitate their children to eat more F&V and advise them to make F&V more available at home.

Although most behavioural change theories posit that changes in the presumed determinants precede changes in intakes, behavioural change theories \(^{14}\) also suggest that behaviour change may precede and induce changes in such factors as liking as well as perceived environmental factors. We therefore investigated if changes or maintenance of favorable levels of F&V intake frequency predicted changes in presumed determinants of F&V intake. In the Pro Children Study favorable changes in fruit intake frequency predicted increased knowledge of recommendations of fruit
intake, while in the Schoolgruiten Project increased (or maintenance of favorable levels of) F&V intakes frequency predicted increased or maintenance of high scores of liking of F&V. These results may be regarded as support for a more direct relation between F&V interventions and intakes, as suggested in dual process models. More research is needed to further explore such direct pathways between interventions and changes in intake levels.

As already mentioned in the introduction of this paper, most studies investigating correlations between F&V intake and their determinants apply cross-sectional designs that do not allow conclusions about prediction or causation. Likewise, most studies conducting mediation analyses aim at explaining intervention effects and assess changes in behaviour and changes in potential mediators within the same time interval. The present findings confirm suggestions from cross-sectional studies that liking of F&V and perceived social environmental factors of F&V are indeed important predictors of F&V intake. Liking was also effected by changes in F&V intake frequency, suggesting a reciprocal relation between F&V intake and liking.

To our knowledge, no other studies have investigated the association between changes in determinants and changes in F&V intake among children in different time intervals. The study of Kvaavik et al. looked at psychosocial determinants and F&V among adults over an eight-year follow-up period and found that attitudes (men), subjective norms (men), perceived behavioural control (women) and perceived social norms (women) at age 25 predicted F&V intake at age 33 in men and women. In addition, there are some longitudinal studies available that looked at other health behaviours among adolescents and young adults. De Bourdeaudhuij et al. concluded that baseline psychosocial variables were poor predictors of physical activity change among 16-25 year olds, but that determinants’ change scores accounted in males for 16%-19%, and in females for 7%-24% of the variance in physical activity. Van de Ven et al. found that baseline smoking-related cognitions predicted smoking onset later in time. Chang et al. also looked at predictive factors related to smoking onset later in time and found that peer smoking, peers offering cigarettes, alcohol use and lower protective factors in the 10th grade predicted smoking initiation by grade 12. They also found that decreases in risk factors and increases in protective factors were associated with youth smoking cessation. Unfortunately, these studies used two repeated measurements in time and were therefore not able to study changes in determinants and behaviours in different time intervals. Furthermore, they did not study whether behaviour change could predict changes in presumed determinants.

Some limitations of the present study need to be addressed. First, all measurements were based on self-reported data, which may have resulted in social desirable answers.
Second, the time-period between baseline and both follow-ups was rather long, and many more changes may have occurred in between that were not captured in the measurements. In addition, for the interpretation of the findings, we have to keep in mind that we not only studied associations between changes in determinants and changes in intake frequency. Children that maintained high scores on determinants or kept favorable levels of intake of F&V were also included in the category representing positive change. This might have blurred the findings. However, sensitivity analyses excluding the children that showed no change in either the determinants or intake, only marginally influence the effect estimates.

CONCLUSION

In accordance with behaviour change theories, the present study provides some evidence that behaviour change (increased intake or maintenance of favorable levels of F&V frequency) was preceded by changes in or maintenance of high scores of (some) presumed determinants of F&V intakes, both in the Pro Children Study and in the Schoolgruiten Project. Determinants of F&V intake that appear to be important to induce behaviour change were liking of F&V, facilitation by the parents of F&V, family rules for eating F&V and availability at home of F&V. Furthermore, changes in F&V intake frequency also induced changes in liking of F&V and knowledge of recommended intake levels of fruit.

REFERENCE LIST


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Chapter 3


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Part II

Measurement issues of intake
Parent and child reports of fruit and vegetable intakes and related family environmental factors show low levels of agreement.

Paper published as:
ABSTRACT

Objective: The purpose of the present study was to determine the level of agreement between child and parent reports of 9-10-year old children’s consumption of fruit and vegetables (F&V) and potential family-environmental determinants.

Methods: Schoolchildren and their parents completed parallel questionnaires at baseline and at follow-up (1 year later) about usual F&V consumption of the child, potential determinants and general demographics. Matched child-parent couples were included in the analyses (baseline = 380; follow-up = 307). To assess the level of agreement between child and parent reports at both points in time, dependent samples t-test, correlation coefficients, weighted Cohen’s kappa coefficients and Bland-Altman plots including limits of agreement were used.

Results: Both at baseline and at follow-up, the mean intakes of F&V reported by the children were significantly higher than reported by their parents, but differences were smaller at follow-up. Correlation coefficients between child and parent reports (0.28 – 0.43) and weighted Cohen’s kappa coefficients (0.25 – 0.28) were weak to moderate. Limits of agreement were wide.

Conclusion: The agreement between parent and child reports is weak to moderate and may depend on the age of the child. Fourth graders may overestimate their own intakes of F&V.
INTRODUCTION

Many epidemiological studies have shown health benefits resulting from eating sufficient fruit and vegetables (F&V) and reported decreased risk for certain types of cancer, heart disease, and obesity. In most industrialized countries a considerable part of the population, including children, have low F&V intake. This is also the case in the Netherlands. In line with efforts in other countries, several campaigns and interventions have been conducted in the Netherlands, including projects such as Krachtvoer (“power food”), Pro Children, and Schoolgruiten (“School fruit and vegetables”). The present study used data from Schoolgruiten, a campaign for primary school children. The main strategy of the Schoolgruiten Project was to improve accessibility of F&V at school through providing two times a week a serving of fruit or vegetable for free to all children. Evaluation of such interventions should be based on accurate and valid assessments of intake levels as well as assessments of determinants or mediators of intakes. Nevertheless, collecting accurate dietary intake data by means of observations or biomarkers in large study samples is often infeasible and too expensive. Food frequency questionnaires are therefore generally used. However, these questionnaires rely on participants’ memory and cognition, which may influence the accuracy of the reported intake. Young children may not be able to perform this complex cognitive task, because of their developmental stage. Primary schoolchildren may have limited recall skills, low ability to estimate and indicate portion size, and lack of knowledge of foods to provide valid information about food frequency, which results in overestimation of portions sizes of their meals. Moreover, the study of Lytle et al. showed that third graders overestimated their intake of F&V. In the study of Andersen et al. sixth graders overestimated their fruit and juice intake, using a 24-h recall. Therefore, in surveys among younger children, parents are often asked to provide information about children’s diets. It is assumed that parents have the ability to recall the food consumption of their children, as they are responsible for their meals at home and at school. In the Netherlands, two thirds of the schoolchildren eat at home during the lunch break. When the children stay at school, they bring their own sandwiches and preferably fruit, prepared by the parents, as no school meals are typically offered.

Besides dietary information, parents are also believed to be able to provide objective information on F&V accessibility, skills and preferences at home.

In the Schoolgruiten Project, both children and their parents responded to parallel questionnaires assessing children’s F&V intake, allowing us to compare children’s and their parent’s reports. Moreover, questions of probably the most important family-
environmental determinants of F&V intakes were measured in these questionnaires. The purpose of the present study was to determine the level of agreement between child and parent reports of the child’s consumption and of potential family-environmental determinants of F&V intakes. This was investigated at baseline and after 1 year of follow-up, thus providing the opportunity to explore whether agreement between reports improved when the children were 1 year older.

METHODS

Selection of the schools and the study sample
We used data from the baseline and follow-up measurements of the control group of the Schoolgruiten evaluation study. This control group consisted of children from 20 primary schools in three medium-size cities in the Netherlands (Zoetermeer, Leidschendam and Hengelo). The intervention group consisted of children from other cities, so the children from the control group were not influenced by the intervention. Only children from the fourth grade (in accordance with the rules of the Dutch Ministry of Education, Culture and Science, these children are 9 and 10 years old) participated in this survey. Children who were older, for instance, because they have done a grade two times, were excluded from this survey. All fourth grades from primary schools in the cities were eligible for participation and schools were randomly approached over telephone, and invited to participate in this survey. Recruitment ended when 20 schools had agreed to participate, ensuring a sample of at least 600 children of the fourth grade.

For one city (Hengelo), records were kept to assess school willingness to participate. Sixteen schools were invited to participate in that city of which half immediately agreed, four refused and another four schools had to consult their external school board before confirming participation. Only the eight schools that immediately agreed were included in the study. Similar procedures and rates of agreement were found in the other cities. The baseline survey was conducted in Zoetermeer and Leidschendam in the spring of 2003 and in Hengelo in the autumn of 2003. Follow-up was 1 year later among the same children.

Procedure
Children filled in the questionnaire guided by their own teacher in their classroom, based on a written administration protocol provided by the Schoolgruiten research
staff. All children completed the questionnaires within one school hour. At baseline and at follow-up the children brought home a questionnaire (meant for parents) to be completed by one of their parents, preferably the parent usually taking care of the child’s meals. All children of the fourth grade who were present on the day and hour of administration filled in the questionnaires, [633 children (100%) and 555 parents (response of 88%)]. Three schools were not willing to participate anymore at follow-up, resulting in fewer children at follow up, [525 children (83%) and 436 parents (response of 69%)]. As the purpose of the study was to determine the level of agreement between 9- and 10-years-old children and their parents’ reports, only data from these matched child-parent couples were included for analyses. It was necessary that they have completed all questions on intake. A total of 380 and 307 matched child-parent couples participated at baseline and at follow-up, respectively. Dropout was due to non-participation of the three schools (n=45), children who had moved or were sick on day of administration (n=26), and unavailable matched parent questionnaires at follow-up (n=54), this was not associated with place of residence. In addition, 52 new children were included at follow-up who were excluded at baseline due to invalid questionnaires.

**Questionnaires**

Separate questionnaires for children and parents were developed for this study. Both questionnaires were based on, and thus quite similar to, the validated questionnaires developed for the Pro Children Project. Using parallel questions in the two questionnaires, the usual intake of F&V among the children and potential determinants of F&V intakes were measured. The child questionnaire was brief, easy to read and self-explanatory, keeping in mind the young age of the children. Frequency questions were used to estimate F&V intakes. (For an overview of the questions, see Appendix). We calculated average daily fruit consumption (in pieces per day) as the number of days when fruit was eaten multiplied by the number of pieces eaten per day, divided by 7. We calculated average daily vegetable consumption (in grams per day) as the number of days when vegetables were eaten multiplied by the amount of vegetables shown on the indicated photographs, divided by 7. The photographs were based on the validated Dutch EPIC Food Frequency Questionnaire. The pictures represent a combination of standard portions - four plates with standard portions of boiled vegetables and four plates with standard portions of composite dishes. A composite dish contains, on average, a third of mixed vegetables. For calculations, we combined these portion sizes by adding up these amounts and dividing by the value of 2. For calculation of raw vegetable consumption, 35 g was considered a standard portion size. This is half of the standard adult portion size according the Netherlands Nutrition Center Foundation.
### APPENDIX

An overview of questions about usual consumption of F&V and the related family environmental questions about fruit and answer alternatives

<table>
<thead>
<tr>
<th>Questions</th>
<th>Response alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consumption of fruit</strong></td>
<td></td>
</tr>
<tr>
<td>How many days a week do you/does your child eat fruit?</td>
<td>Never - every day (8 alternatives, range 0-7)</td>
</tr>
<tr>
<td>How many pieces of fruit do you/does your child eat per day?</td>
<td>Less than one piece of fruit per day (0.5), one (1), two (2), three (3) and more than three (4)</td>
</tr>
<tr>
<td><strong>Consumption of vegetable</strong></td>
<td></td>
</tr>
<tr>
<td>How many days a week do you/does your child eat vegetables?</td>
<td>Never - every day (8 alternatives)</td>
</tr>
<tr>
<td>How many vegetables do you/does your child eat per day?</td>
<td>Four plates with standard portions of boiled vegetables; 25, 50, 100 and 150 g, and four plates with standard portions of composite dishes; 125 g (42 g vegetable), 200 g (67 g vegetable), 250 g (83 g vegetable) and 325 g (108 g vegetable). For calculations we averaged these portion sizes, resulting in the following amounts of vegetable; 34, 59, 92 and 129 g</td>
</tr>
<tr>
<td>How often do you/does your child eat raw vegetables?</td>
<td>Often [6 times a week = 210 g per week (6*35 g)]</td>
</tr>
<tr>
<td><strong>Variety</strong></td>
<td></td>
</tr>
<tr>
<td>Do you / does your child always eat different types of fruit, or the same kind?</td>
<td>Always the same type - Often the same, but sometimes others - Different types</td>
</tr>
<tr>
<td><strong>Availability</strong></td>
<td></td>
</tr>
<tr>
<td>Is fruit always available at home?</td>
<td>Often - Sometimes - Never</td>
</tr>
<tr>
<td><strong>Rules at home</strong></td>
<td></td>
</tr>
<tr>
<td>Are you allowed to take fruit yourself when you want it, or do you have to ask for it? (Is your child allowed to take fruit when he/she wants it, or does he/she have to ask for it?)</td>
<td>Always - Sometimes - Never</td>
</tr>
<tr>
<td>Does your father or mother prepare fruit for you to eat? (Do you prepare fruit for your child?)</td>
<td>Always - Sometimes - Never</td>
</tr>
<tr>
<td>Does your father or mother often eat fruit together with you? (Do you often eat fruit together with your child?)</td>
<td>Always - Sometimes - Never</td>
</tr>
</tbody>
</table>
Total vegetable intake was the sum of boiled and raw vegetables. Potatoes were excluded, as it is not considered a vegetable in the Netherlands, nor in most European research. The questionnaires also included questions about variety, availability and rules at home about fruit. (See also Appendix for an overview of these questions and response alternatives.)

The parent questionnaire also included questions on the parent’s country of birth, education level, age, child’s age and number of siblings. Information on the country of birth was used to make distinctions between native Dutch children, children of Western immigrants and children of non-Western immigrants, according to the definition of the Dutch Institute of Statistics. Two educational-level categories were formulated, based on the highest educational level reported. (Primary school, low-level vocational training or medium-level vocational training=low; high school, high-level vocational training, college or university training=high).

**Statistical methods**

Means, standard deviations and percentages were calculated to describe the key variables. Continuous dependent variables (frequency of F&V intake) were checked for normality. Some variables showed skewed distributions (skewness > 1) (parental reports of F&V at baseline and follow-up), others showed peaked distributions (kurtosis > 1) (child reports on vegetable intake at baseline and follow-up, all calculated differences between child and parent reports except fruit intake at baseline). Therefore, analyses including these variables were performed using non-parametric (Wilcoxon signed-rank test, Mann-Whitney U-test, and Spearman correlation) as well as parametric tests. Results from the non-parametric tests were similar to those from the parametric tests; therefore, the latter results were reported. Results from parametric tests are easier to interpret and additionally provide ‘real’ effect sizes instead of rank scores.

Different techniques were used to assess the level of agreement between child and parent reports. First, paired sample t-tests were used to assess differences in mean values between children and parents, at baseline as well as at follow-up. Paired sample t-tests were used to assess if mean difference between children and parent reports were significantly smaller at follow-up, for fruit as well as vegetable intakes. Secondly, it was analysed how many children reported a higher, an equal (within 10% over- or underestimation) or a lower intake of F&V compared with their parent’s report. Furthermore, the consumption levels of F&V per day were divided into four equal groups for parents and children reports, and 4 x 4 tables were created for which weighted Cohen’s kappa coefficients were calculated. It was also analysed how many parents and children were in the same, in the adjacent or the more distant quartiles.
To assess associations between child and parent reports, Pearson correlation coefficients were calculated. To assess level of agreement, the graphical method suggested by Bland & Altman was used. In this graphical method, the difference between the two assessments was plotted against the mean of these two. Limits of agreement were calculated as mean difference ± 1.96 times the standard deviation of the mean difference and drawn as horizontal lines in the scatter plot. This technique does not test the statistical significance of the level of agreement, but is rather a “quality control” concept. The mean difference between the two methods and the levels of agreement provide important information about the amount and direction of bias. In an ideal situation the mean differences should be zero, the limits of agreement should be close to the mean difference, and 95% of the data observations should lie within the ±2SD of the mean difference. Moreover, it is important that the observations are nicely distributed around the mean difference and do not show a specific pattern.

We further assessed by means of the independent samples t-test, whether the discrepancy between child and parent reports differed by gender (boys versus girls), ethnicity (native Dutch versus non-Western immigrants), parents’ level of education (low versus high), number of siblings (≤1 versus >1) and the child’s level of F&V consumption (below median of averaged parent and child report versus higher than median of this averaged intake).

For the categorical outcome measures variety, availability and rules at home about fruit, the level of agreement was assessed with weighed Cohen’s kappa coefficients. It was also analysed how many parents and children gave the same, the adjacent or the more distant answer.

The data were analysed using SPSS 11.0 (SPSS Inc., Chicago, IL, USA, 1999). The weighted Cohen’s kappa coefficients were conducted using SAS software (Version 8.2, SAS Institute Inc., Cary, NC).

**RESULTS**

**Characteristics of the participants**

As shown in TABLE 4.1, the study sample consisted of slightly more girls than boys. The majority of the children were of native Dutch origin. At baseline, age of all children ranged between 8.9 and 10.4 years; for parents, this was 28.5-61.0 years. The mean age of the children was 9.7 years (SD = 0.4) at baseline and 10.8 years (SD = 0.3) at follow-up.
**TABLE 4.1**: Characteristics of the study population at baseline and at follow-up

<table>
<thead>
<tr>
<th>Characteristics of the study population</th>
<th>Baseline measurement</th>
<th>Follow-up measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean (SD) or %</td>
</tr>
<tr>
<td>Age of the children, years</td>
<td>380</td>
<td>9.7 (0.4)</td>
</tr>
<tr>
<td>Age of the parents, years</td>
<td>367</td>
<td>40.3 (5.0)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>175</td>
<td>46.1</td>
</tr>
<tr>
<td>Girls</td>
<td>205</td>
<td>53.9</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native Dutch children</td>
<td>278</td>
<td>73.1</td>
</tr>
<tr>
<td>Children of Western immigrants</td>
<td>22</td>
<td>5.8</td>
</tr>
<tr>
<td>Children of non-Western immigrants</td>
<td>80</td>
<td>21.1</td>
</tr>
<tr>
<td>Educational level of the parents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>61</td>
<td>16.4</td>
</tr>
<tr>
<td>High</td>
<td>312</td>
<td>83.6</td>
</tr>
<tr>
<td>Number of siblings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>29</td>
<td>7.6</td>
</tr>
<tr>
<td>1</td>
<td>190</td>
<td>50.0</td>
</tr>
<tr>
<td>2</td>
<td>93</td>
<td>24.5</td>
</tr>
<tr>
<td>&gt;=3</td>
<td>68</td>
<td>17.9</td>
</tr>
</tbody>
</table>

**Agreement between parent and child reports**

Both at baseline and at follow-up, the mean intakes of F&V reported by the children were significantly higher than that reported by their parents (see TABLE 4.2), but the differences were significantly smaller at follow-up, for fruit as well as vegetable intakes (p<0.001). At baseline 61.3% of the children reported a higher and 20.7% a lower fruit intake than their parents. At follow-up, 51.7% of the children reported a higher and 23.2% a lower fruit intake than their parents. At baseline, 71.5% of the children reported a higher and 15.6% a lower vegetable intake than their parents. At follow-up, 61.0% of the children reported a higher intake and 21.0% a lower vegetable intake than their parents.

**TABLE 4.2**: F&V intakes reported by children and parents at baseline and at follow-up

<table>
<thead>
<tr>
<th>Primary outcomes</th>
<th>N</th>
<th>Children, mean (SD)</th>
<th>Parents, mean (SD)</th>
<th>Mean differences (SD) (children – parents)</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit in pieces per day, at baseline</td>
<td>372 / 372</td>
<td>1.72 (1.15)</td>
<td>1.08 (0.74)</td>
<td>0.64 (1.10)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fruit in pieces per day, at follow-up</td>
<td>302 / 302</td>
<td>1.40 (0.91)</td>
<td>1.11 (0.80)</td>
<td>0.30 (0.94)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Vegetables in grams per day, at baseline</td>
<td>358 / 358</td>
<td>102.5 (50.1)</td>
<td>67.1 (31.0)</td>
<td>35.4 (51.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Vegetables in grams per day, at follow-up</td>
<td>305 / 305</td>
<td>93.2 (39.6)</td>
<td>72.2 (34.1)</td>
<td>21.0 (40.4)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

* estimated by t-test for paired samples
As children from the two regions were assessed during either spring or autumn, season might have influenced the reported intakes. However, no significant differences in reported intakes were found by season or region of residence (data not shown).

At follow-up, slightly less children and parents were in the same or adjacent quartile as compared with the baseline measurement for fruit intake. For vegetable intake, slightly more children and parents were in the same or adjacent quartile at follow-up compared with the baseline measurement. The weighted Cohen's kappa coefficients were all low and ranged between 0.25 and 0.28 (see TABLE 4.3). Both at baseline and at follow-up, the children's reports were significantly correlated with parent reports, for fruit as well as vegetable intakes (fruit: 0.39, 0.41; vegetable: 0.28, 0.41, respectively; all P < 0.001).

**TABLE 4.3:** Accordance of quartiles of F&V intakes at baseline and at follow-up, reported by children and parents and the accompanying weighted Cohen's kappa coefficients

<table>
<thead>
<tr>
<th></th>
<th>Same quartile</th>
<th>Adjacent quartile</th>
<th>Different quartile</th>
<th>Kappa (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption of fruit, baseline</td>
<td>134 (36.0)</td>
<td>153 (41.2)</td>
<td>85 (22.8)</td>
<td>0.25 (&lt;0.001)</td>
</tr>
<tr>
<td>Consumption of fruit, follow-up</td>
<td>105 (34.8)</td>
<td>125 (41.4)</td>
<td>72 (23.8)</td>
<td>0.28 (&lt;0.001)</td>
</tr>
<tr>
<td>Consumption of vegetables, baseline</td>
<td>140 (39.1)</td>
<td>125 (34.9)</td>
<td>93 (26.0)</td>
<td>0.25 (&lt;0.001)</td>
</tr>
<tr>
<td>Consumption of vegetables, follow-up</td>
<td>100 (32.8)</td>
<td>140 (45.9)</td>
<td>65 (21.3)</td>
<td>0.25 (&lt;0.001)</td>
</tr>
</tbody>
</table>

The Bland and Altman scatter diagrams presenting the agreement between the child and parent reports of F&V intakes at baseline (see FIGURES 4.1 and 4.2), show that disagreement was larger at higher average intakes. The mean difference was reduced from 0.64 pieces per day at baseline to 0.30 pieces per day at follow-up, with rather wide limits of agreement (baseline range: -2.79 to 1.52, follow-up range: -2.13 to 1.54). Similar trends were found for vegetable intakes. The Bland and Altman scatter diagrams for the report of F&V intakes at follow-up were comparable with the baseline diagrams. Low fruit consumers (<1.29 pieces per day, median of averaged parent and child report) showed significantly better agreement than high consumers (mean difference of -0.21 pieces per day vs. -1.04 pieces per day, P < 0.001). Moreover, at follow-up the low fruit consumers showed a significantly better agreement than the high consumers (-0.15 versus -0.45 pieces per day, P = 0.006).
Child and parent reports of fruit and vegetables intakes

Both at baseline and follow up, low vegetable consumers (<81.3 g day⁻¹, median of averaged parent and child report) showed significantly (P < 0.05) better agreement than high consumers (baseline: -17.4 versus -53.2 g day⁻¹; follow-up -12.8 versus -23.6 g day⁻¹).

At baseline, agreement between parent and child reports for fruit as well as vegetable intake was significantly lower for children of non-Western immigrants (fruit: non-Western immigrants’ children -1.11 pieces day⁻¹ versus native Dutch children -0.54 pieces day⁻¹, P = 0.012; vegetables: non-Western immigrants’ children -53.1 g day⁻¹ versus native Dutch children -30.2 g day⁻¹, P=0.007). At follow-up, level of agreement regarding fruit intake did not differ by ethnicity. For vegetable intake we found an opposite result, agreement between parent and child reports was significantly lower for native Dutch children (-20.4 g day⁻¹) than for children of non-Western immigrants (-5.1 g day⁻¹), P = 0.024.

Agreement on potential determinants

TABLE 4.4 shows the agreement on potential determinants of fruit intake with weighted Cohen’s kappa coefficient ranging from 0.12 to 0.31, for baseline and follow-up measurement. At follow-up, more children and parents gave the same answers compared with the baseline measurement. This was supported by higher values of the weighted Cohen’s kappa coefficients.

FIGURE 4.1: Scatter diagram of Bland & Altman of the consumption of fruit in pieces per day, at baseline
FIGURE 4.2: Scatter diagram of Bland & Altman of the consumption of vegetables in grams per day, at baseline

TABLE 4.4: Agreement between child and parent reports on potential determinants of fruit intake, at baseline and at follow-up, and the accompanying weighted Cohen's kappa coefficients

<table>
<thead>
<tr>
<th></th>
<th>Same answer</th>
<th>Adjacent answer</th>
<th>Different answer</th>
<th>Kappa (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eat different kinds of fruit? Baseline measurement</td>
<td>227 (61.8)</td>
<td>132 (36.0)</td>
<td>8 (2.2)</td>
<td>0.27 (&lt;0.001)</td>
</tr>
<tr>
<td>Eat different kinds of fruit? Follow-up measurement</td>
<td>188 (62.9)</td>
<td>101 (33.8)</td>
<td>10 (3.3)</td>
<td>0.26 (&lt;0.001)</td>
</tr>
<tr>
<td>Fruit available at home? Baseline measurement</td>
<td>298 (81.4)</td>
<td>62 (17.0)</td>
<td>6 (1.6)</td>
<td>n.a.</td>
</tr>
<tr>
<td>Fruit available at home? Follow-up measurement</td>
<td>265 (88.3)</td>
<td>32 (10.7)</td>
<td>3 (1.0)</td>
<td>n.a.</td>
</tr>
<tr>
<td>Allow getting fruit by his/her own? Baseline measurement</td>
<td>206 (56.6)</td>
<td>129 (35.4)</td>
<td>29 (8.0)</td>
<td>0.22 (&lt;0.001)</td>
</tr>
<tr>
<td>Allow getting fruit by his/her own? Follow-up measurement</td>
<td>189 (63.1)</td>
<td>92 (30.6)</td>
<td>19 (6.3)</td>
<td>0.21 (&lt;0.001)</td>
</tr>
<tr>
<td>Prepare fruit by his/her own? Baseline measurement</td>
<td>163 (45.3)</td>
<td>182 (50.5)</td>
<td>15 (4.2)</td>
<td>0.23 (&lt;0.001)</td>
</tr>
<tr>
<td>Prepare fruit by his/her own? Follow-up measurement</td>
<td>163 (54.4)</td>
<td>117 (39.0)</td>
<td>20 (6.6)</td>
<td>0.31 (&lt;0.001)</td>
</tr>
<tr>
<td>Eat together fruit or not? Baseline measurement</td>
<td>147 (40.5)</td>
<td>181 (49.9)</td>
<td>35 (9.6)</td>
<td>0.12 (0.002)</td>
</tr>
<tr>
<td>Eat together fruit or not? Follow-up measurement</td>
<td>144 (48.2)</td>
<td>131 (43.7)</td>
<td>24 (8.1)</td>
<td>0.19 (&lt;0.001)</td>
</tr>
</tbody>
</table>

n.a. – not applicable because empty cell
DISCUSSION

The present study showed low agreement between child and parent reports on intake and potential family determinants of F&V intakes of the child. The mean intake of F&V reported by the children was significantly higher than those reported by their parents, both at baseline and at follow-up. In only 12.9%-25.2% of the cases, parents and children reported approximately the same (within 10% over- or underestimation) fruit or vegetable intakes. Although, for both F&V more than 76% of children were in the same or adjacent quartile of intake based on the parent and child reports, at baseline as well as at follow-up, all other indicators showed poor to moderate agreement between the two reports.

Stratified analyses showed better agreement among low consumers than among high consumers for both F&V intakes, which may be partly due to the lower range in intake levels among children with lower intakes. A better agreement between parent and child reports was found among native Dutch children compared with children from non-Western origin. Preliminary results of this project and results of the Pro Children study in a similar population showed that children from non-Western immigrants may have higher fruit intakes than the Dutch children and subsequently are more likely to be in the high consumer group, which may be one reason for the poorer agreement.

Although weighted Cohen’s kappa coefficients were not substantially higher at follow-up, the absolute difference after 1 year between child and parent reports decreased for both F&V intakes and the limits of agreement became less wide, indicating that agreement between reports improves with age. This was not biased by selective drop out of matched cases with poor agreement such as non-Western immigrants (see TABLE 4.1), high consumers or the three schools that dropped out at follow-up (data not shown). Better agreement at follow-up might also be a result of increased awareness of F&V intake caused by participation in this study. On the other hand, the current sample consisted solely of children from the control group and the time interval between the two measurements was 1 year.

Bland and Altman scatter plots were used as an additional indicator for agreement between parent and child reports of F&V intakes. These plots do provide a good visualization of agreement, but unfortunately no guidelines yet exist for weak, moderate or good agreement for dietary intake data. Agreement in reports of potential determinants of intake was better than for intakes, and agreement for these determinants also improved between baseline and follow-up.

The reported mean F&V intakes by the parents are in line with the intake levels reported for the Netherlands in the Pro Children Study, as well as results from the earlier
Dutch National Food Consumption Survey. Accordingly, the parent reports could be considered as a valid method measuring the children’s F&V intake. Subsequently, present findings indicate that the children were not capable enough to fill in the questionnaire adequately at baseline - most probably because they were too young, since agreement improved after 1 year. The improvement in agreement was not likely to be caused by age-related lower intake at follow-up, because intake at follow-up was not lowered, according the parent reports which were considered as most accurate. Moreover, in the Netherlands, two-thirds of the schoolchildren eat at home during the lunch break. When the children stay at school, they bring their own sandwiches and, preferably, fruit, prepared by the parents, as no school meals are typically offered. Furthermore, in almost all Dutch primary schools, no food can be obtained from vending machines or otherwise, and children are not allowed to leave the school or schoolyard during school hours. Therefore, it is reasonable to assume that the parents know what their children eat during the three main meals, as well as snacks eaten at school. Nevertheless, it must be realised that children do not constantly share the same environment with their parents and that this might affect the adequacy of the parent’s reports. Therefore, from this survey alone, it cannot be determined whether the parents or the children gave the “correct” answers. Hardly any study reporting on child-parent comparisons of eating behaviours, especially F&V intakes, was found in the literature. Bere and Klepp investigated parent-child report comparisons, but only regarding correlates of the children’s intake of F&V, including children’s accessibility, skills and preferences. The parent-child correlations were moderate. The scales they used for children and parents were aimed at measuring the same construct, but the authors concluded that one could not be substituted for the others. The parents perceived their children’s accessibility to be much higher than the children did themselves, whereas, the children perceived their own skills to be higher than their parents did.

Studies comparing child and parent reports on other topics than dietary intake have found contradicting results. Although it is a very different topic, Chang and Yeh concluded in their survey about quality of life of children with cancer that parent proxy reports on quality of life were more valid than child reports for children who are younger than 12 years but less valid for adolescents. Our data may indicate that the same may be true for dietary assessments of 9- to 10-year-old children.

Another explanation of the low agreement between parent and child reports is that the questionnaire was not appropriate for children of this age. Maybe that a different assessment method, such as face-to-face or an observation method would have produced better agreement, because such methods are less dependent of memory and estimates. More studies are needed on this topic.
CONCLUSION

It can be concluded that agreement between parent and child reports of F&V intakes and potential family determinants is weak to moderate. This may be dependent on the age of the child, as disagreement was stronger for fourth graders compared to fifth graders. Fourth graders may overestimate their own intakes of F&V. Differences in agreement seem further dependent on level of consumption and ethnicity, at least for the younger children.

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Child and parent reports of fruit and vegetables intakes


Part III

Evaluation of the Schoolgruiten Project
Ethnic differences in one-year follow-up effect of the Dutch Schoolgruiten Project - promoting fruit and vegetable consumption among primary schoolchildren

Paper published as:
ABSTRACT

Objective: To evaluate the effect of a primary school based intervention providing free fruit and vegetable (F&V), separately for children of Dutch and of non-Western ethnicity.

Setting: Primary schools in two regions (west and east) in the Netherlands

Design and methods: Participating schoolchildren and their parents completed questionnaires at baseline and 1 year later, including questions on usual F&V intake, potential determinants and general demographics. Primary outcome was the usual fruit intake and the usual vegetable intake as assessed by parent- and child self-reported food frequency measures. Secondary outcome measures were child- or parent-reported taste preference, knowledge of daily recommendations, availability, and accessibility for fruit intake. Multi-level regression analyses were used to assess differences at follow-up adjusted for baseline values between the control and intervention group using both child and parent-reports.

Subjects: Five hundred and sixty-five children of Dutch ethnicity and 388 children of non-Western ethnicity (mean age 9.9 years at baseline) and their parents.

Results: Children of non-Western ethnicity in the intervention group reported a significant higher vegetable intake (difference = 20.7g day⁻¹, 95% confidence interval (CI) = 7.6-33.7). A significant positive intervention effect was also found for fruit intake for children of Dutch ethnicity (difference = 0.23 pieces day⁻¹, 95% CI = 0.07–0.39). No significant effects in intake were observed based on parent reports. Significant positive intervention effects were also found for perceived accessibility among children of non-Western ethnicity, and for parent-reported taste preference of their child among children of non-Western ethnicity and boys of Dutch ethnicity.

Conclusion: Providing children with free F&V had some positive effects on child-reported intakes and important correlates of intakes.
In many Western countries, including the Netherlands, schoolchildren often do not comply with dietary recommendations. Notably, as shown in a recent European study, fruit and vegetable (F&V) intakes are lower than the national guidelines. Epidemiological evidence for an association between eating enough F&V and a decreased risk for chronic metabolic diseases like obesity, hypertension and diabetes mellitus type 2 is convincing. Therefore, various interventions have been developed aiming to increase F&V intakes among children. Food habits acquired in childhood to a certain extent track into adolescence and adulthood, arguing for the promotion of adequate F&V consumption among schoolchildren. Moreover, behavioural habits in children may not be as firmly rooted as in adults.

The Dutch recommendations for F&V intake for 10-12-year-old children are two pieces of fruit (about 200-250 g) and 150-200 g vegetables per day. In the Netherlands, a number of interventions have been developed to promote compliance to these recommendations. The largest-scale Dutch intervention is ‘Schoolgruiten’, which is a Dutch acronym for ‘school fruits and vegetables’. The Schoolgruiten Project is meant to grow into a nationwide campaign for primary schoolchildren, but started with a pilot phase in which the intervention was tested in a controlled design, to inform further improvement of the intervention or justify further implementation.

In the Netherlands, especially in the major cities in the western part of the country, a growing minority, in some cities up to 50% of the children, has a non-Western background; at least one of their parents was born in a non-Western country, especially Morocco, Turkey, Surinam or the Netherlands Antilles. Evidence suggests that these children have different eating patterns, including different F&V intakes, than children of Dutch ethnicity. Furthermore, intervention studies hardly ever look at differential effects according to such factors as ethnicity, while it is important to explore such possible moderators to identify special interest groups. Since the Schoolgruiten Project was not specifically tailored to ethnic minority groups, and because some of these minority groups have higher mean intake levels, it might be expected that the intervention is less effective in these groups.

In summary, the aim of the present study was to evaluate the 1-year follow-up effect of the Schoolgruiten Project regarding F&V consumption and important correlates of F&V consumption among European schoolchildren. Knowledge of recommendation, taste preferences, availability and accessibility. This was done separately for children of Dutch and of non-Western ethnicity. Furthermore, interactions with gender and educational level of the parents were explored, and further stratification was carried...
out accordingly. We hypothesized that the intervention would have a significant effect on F&V intakes and that the intervention would be less effective among the children of non-Western ethnicity compared with the ethnic Dutch children.

METHODS

The Schoolgruiten Project
Since earlier studies and reviews indicate that taste preferences, availability and accessibility are important determinants of F&V consumption among children, and because intakes should be promoted through changes in such presumed mediators, the main strategies within the Schoolgruiten Project targeted these factors. First, availability and accessibility of F&V at school was improved through a F&V scheme. The children in the intervention group received a piece of fruit or ready-to-eat vegetables (cherry tomatoes, baby carrots) for free twice a week at the mid-morning break. The aim of the Schoolgruiten Project was that all children eat the piece of fruit or vegetable together in their own classroom. Apart from increasing availability and accessibility, this F&V scheme was also supposed to increase the children’s exposure to F&V. Repeated exposure is an important determinant of taste preferences.

Additionally, a school curriculum, developed and carefully pre-tested by the Netherlands Nutrition Center Foundation that aimed to increase knowledge and skills related to F&V consumption, was offered to the intervention schools. The intervention schools were not obliged to use this curriculum, but they were encouraged to do so.

Recruitment of the schools and study sample
The Schoolgruiten Project was implemented in seven cities of the Netherlands. These seven cities where indicated by the Dutch ministry of Public Health, Welfare and Sport. Because of time and financial constraints only two of these cities were included in the evaluation study. These were The Hague, a major city in the west of the Netherlands, and Almelo a medium size city in the east. The design of the evaluation study was quasi experimental, with a pre- and post-test, and an intervention and a control group. Since the intervention cities were decided upon by the authorities, no randomisation was possible. The Schoolgruiten research group selected three control cities: Zoetermeer and Leidschendam close to The Hague, and Hengelo, which is close to Almelo.

Participating children were from the 4th grade (age 9-10 years). All 4th grades from primary schools in the cities were eligible for participation and schools were randomly
approached by telephone and invited to participate in this survey. Recruitment ended when 50 schools had agreed to participate, ensuring a sample of at least 600 children of the 4th grade in the intervention as well as in the control group. For one city (Hengelo) records were kept to assess school willingness to participate. Sixteen schools were invited to participate in that city of which half immediately agreed, four refused and another four schools had to consult their external school board before confirming participation. Only the eight schools that immediately agreed were included in the study. Similar procedures and rates of agreement were found in the other cities.

The baseline measurement was conducted before the intervention started and the follow-up measurement was conducted exactly one year later. The baseline survey was conducted in The Hague, Zoetermeer and Leidschendam in the spring of 2003 and in Almelo and Hengelo in the autumn of 2003.

For the evaluation study both children as well as their parents completed questionnaires about the child’s intake and potential determinants, allowing evaluation based on child as well as parent-reports.

**Procedure**

Children completed the questionnaire within one school hour guided by their own teacher in their classroom, based on a written administration protocol provided by the research staff.

At baseline and follow-up the children brought home a parent questionnaire to be completed preferably by the parent who usually took care of the child’s meals. The children got a small present, when they returned the completed parent questionnaire. All children of the 4th grade who were present on the day and hour of administration completed the questionnaires - 1328 children (100%) and 1070 parents at baseline (response of 81%). Five schools were no longer willing to participate at follow-up, resulting in fewer children at follow up - 1140 children (86%) and 931 parents (response of 70%). Since the study purpose was to evaluate the 1-year follow-up effects of this intervention, only the children who completed the questionnaire at baseline and follow-up were included for analyses. Furthermore, only children who completed all questions on fruit intake or all questions on vegetable intake were included in analyses for fruit or vegetables. The same applied for the parental reports of the child’s F&V intake.

A total of 565 (232 intervention and 333 control) children of Dutch ethnicity and a total of 388 (268 intervention and 120 control) children of non-Western ethnicity were included for analyses. Children with valid self-reported data on fruit and/or vegetable intake at baseline but not at follow-up were considered as dropouts. Dropout was due
to the loss of five schools (n=112), and because children moved to other places or schools, did not graduate to the next grade, were sick on the day of administration at follow-up (n=194), or had missing F&V reports at follow-up (n=23). Children of Western ethnicity (n=46) were not taken into account in all analyses. Regarding parents, data were available for 458 (195 intervention and 263 control) parents of children of Dutch ethnicity and 247 (160 intervention and 87 control) parents of children of non-Western ethnicity. Parent data of children of Western ethnicity (n=37) was excluded for this study. Dropout was due to the loss of five schools (n=86), parents who moved, who have a child who did not graduate to the next grade or who were sick at the day of administration, parents who refused to complete the questionnaire at follow-up (n=240), and missing F&V intake reports (n=2).

**Questionnaires**

Separate questionnaires for children and parents were developed, both based on the validated Pro Children questionnaires. By parallel questions in the two questionnaires, the usual intake of F&V among the children was assessed with the Pro Children food frequency questions. Taste preference, knowledge of recommendations, accessibility, and availability of fruit were assessed with questions similar to those used in the Pro Children Study. The parent questionnaire also included questions on the parent’s country of birth, level of education, age, child’s age and number of siblings. Information on the country of birth of parents was used to make distinctions between children of Dutch, non-Western, and non-Dutch Western ethnicity (Europe (excluded Turkey), North America, Oceania, Indonesia or Japan), according to the definition of the Dutch Institute of Statistics. When at least one of the parents was born in a non-Western country the child was considered as of non-Western ethnicity. Based on the highest educational level of one of the parents, a division into three groups (low; primary school or pre-vocational training, medium; high school or medium level vocational training, high; high level vocational training, college or university training). A more detailed description of the questions and answer alternatives of the questionnaire has been published previously.

**Statistical analyses**

Since in the present project both child- and parent-report data were available, and it is not clear which data are most valid and sensitive for evaluation of school-based interventions, all analyses were performed on both data-sets.
Selective dropout and selective parent participation were assessed by logistic regression analyses with gender, parent educational level, region of residence of the children (categorical variables), and consumption of fruit or vegetable at baseline (continuous variables) as independent variables. Means, standard deviations (SDs) and percentages were calculated to describe the key variables.

To describe unadjusted, outcomes paired sample \( t \)-tests, \( t \)-test for independent samples, paired Wilcoxon tests and \( \chi^2 \) tests were used. To assess the adjusted effect of the intervention regarding the primary outcomes, multilevel regression analyses were performed to compare fruit or vegetable intakes at follow-up (dependent variable) between intervention (1) and control group (0) (dichotomous independent variable). A multilevel analysis takes into account that effects may cluster within schools/classes. Analyses were further adjusted for children's age, gender, parental education level, region of residence, and baseline intake levels. The estimated regression coefficient reflects the adjusted difference in fruit/vegetable consumption between the intervention and control group. The residuals of the regression analyses were checked for normality and were considered as acceptable.

Effect modification by gender and educational level was assessed by including gender x group or educational level x group interaction terms in the model. When these terms approached significance (P<0.10), analyses were stratified.

As suggested by Twisk and Proper \(^{28}\) the change between baseline and follow-up in the categorical variables was assessed by means of multilevel multinomial logistic regression analyses. For these analyses the dependent variables were newly constructed categorical variables, with three categories, which were defined by their scores on baseline and follow up. The categories were: ‘stable high/increased’ (reference group, 0), ‘stable low’ (1) and ‘decreased’ (2). Again, group (intervention=1, control=0) was the independent variable and the analyses were adjusted for children's age, gender, education level of the parents and region of residence. The estimated odds ratio's (ORs) reflect the odds of being in the specific category for the intervention group compared with being in the reference category (=stable high/increased).

The explorative data analyses were done using SPSS 11.0 (SPSS Inc., Chicago, IL, USA, 1999). The multi-level analyses were conducted using MLwiN software (Version 2.01) \(^{29}\). The significance level was set at P<0.05.
RESULTS

Dropout and non-participating parents

Children of Dutch ethnicity

Due to the loss of five schools (three control schools and two intervention schools), selective dropout was found for parents in the control group (OR=1.69, 95% CI=1.14-2.51), for those residing in the eastern region (child data: OR=2.54, 95% CI=1.45-4.43; parent data: OR=2.48, 95% CI=1.58-3.87) and for children who reported lower fruit intake at baseline (OR=0.79, 95% CI=0.62–0.99).

At baseline, children of Dutch ethnicity of non-participating parents were more likely to live in the western region (OR=2.86, 95% CI=1.17-6.94) and to be a boy (OR=2.79, 95% CI=1.23-6.30). At follow-up, the gender difference disappeared, while the difference regarding region of residence remained (OR=2.91, 95% CI=1.83-4.62). At follow-up, the children from non-participating parents were more likely to be in the control group (OR=1.70, 95% CI=1.14–2.55).

Children of non-Western ethnicity

Again, due to the loss of five schools, selective dropout was found in the control group (child data: OR=2.65, 95% CI=1.44-4.85; parent data: OR=1.92, 95% CI=1.15-3.21), children who reported higher fruit intake at baseline (OR=1.33, 95% CI=1.04–1.71) and boys (OR=1.64, 95% CI=1.01–2.65).

At baseline, non-participating parents were more likely to be in the control group (OR=2.75, 95% CI=1.39–5.45), while at follow-up these parents were more likely to be in the intervention group (OR=2.75, 95% CI=1.61-4.67).

Characteristics

Slightly more girls than boys participated (see TABLE 5.1). The majority of the children were of Dutch ethnicity. At baseline, the age of all children ranged between 8.3-12.5 years; for parents this was 25.2-61.0 years.
## TABLE 5.1: Characteristics of the study population at baseline (child data)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Dutch ethnicity</th>
<th>Non-Western ethnicity</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intervention</td>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>Age of the children, years</td>
<td>232 (9.7 (0.5))</td>
<td>333 (9.8 (0.5))</td>
<td>0.339</td>
</tr>
<tr>
<td>Age of the parents, years</td>
<td>208 (39.1 (4.1))</td>
<td>294 (40.3 (4.4))</td>
<td>0.401</td>
</tr>
<tr>
<td>Gender</td>
<td>118 (50.9)</td>
<td>158 (47.4)</td>
<td>0.424</td>
</tr>
<tr>
<td>Educational level of the parents</td>
<td>39 (18.0)</td>
<td>51 (16.0)</td>
<td>0.080</td>
</tr>
<tr>
<td>Number of siblings</td>
<td>0 (10.5)</td>
<td>18 (5.6)</td>
<td>0.108</td>
</tr>
<tr>
<td></td>
<td>1 (51.1)</td>
<td>183 (56.4)</td>
<td>0.046</td>
</tr>
<tr>
<td></td>
<td>2 (26.5)</td>
<td>76 (23.5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;=3 (11.9)</td>
<td>47 (14.5)</td>
<td></td>
</tr>
</tbody>
</table>

SD – standard deviation

* as estimated by X²-test (independent categorical data).
F&V intake (primary outcomes)

Children of Dutch ethnicity
At baseline, the total sample of children of Dutch ethnicity (intervention and control children together) reported a mean daily fruit intake of 1.58 (SD=1.06) pieces and a mean daily vegetable intake of 97.9 (SD=44.3) g.
At follow-up the unadjusted analyses showed higher F&V intake in the intervention than in the control group, except for the parent reported fruit intake (see TABLE 5.2). After adjustments, it appeared that the intervention group had significantly higher fruit intake than the controls according to the child reports (difference = 0.23 pieces day⁻¹, 95% CI=0.07–0.39 (see TABLE 5.3). No other significant differences were observed.

Children of non-Western ethnicity
At baseline, the total sample of children of non-Western ethnicity (intervention and control children together) reported a mean daily fruit intake of 2.02 (SD=1.17) pieces and a mean daily vegetable intake of 120.6 (SD=66.3) g.
A significant interaction (P = 0.084) with parental educational level was found for child-reported fruit intake, but after stratification no significant effect sizes were found in either group (data not shown).
At follow-up the children in the intervention group reported a significantly higher unadjusted vegetable intake than the children in the control group (P = 0.013) (see TABLE 5.2), also after adjustment for the potential confounders (difference=20.7 g day⁻¹, 95% CI = 7.6-33.7) (see TABLE 5.3). No interactions or other significant differences were found for this sub-group.
TABLE 5.2: Fruit and vegetable intakes in the intervention and the control groups, separately for children of Dutch and of non-Western ethnicity, at baseline and at follow-up

<table>
<thead>
<tr>
<th>Primary Outcomes</th>
<th>N Intervention/Control</th>
<th>Intervention group</th>
<th>Control group</th>
<th>Comparisons between groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline Mean (SD)</td>
<td>Follow-up Mean (SD)</td>
<td>P-value*</td>
<td>Baseline Mean (SD)</td>
</tr>
<tr>
<td><strong>Children of Dutch ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent report of fruit intake (pieces day⁻¹)</td>
<td>194/263</td>
<td>1.07 (0.74)</td>
<td>1.22 (0.82)</td>
<td><strong>&lt;0.001</strong></td>
</tr>
<tr>
<td>Child report of fruit intake (pieces day⁻¹)</td>
<td>227/320</td>
<td>1.54 (1.04)</td>
<td>1.55 (0.93)</td>
<td>0.798</td>
</tr>
<tr>
<td>Parent report of vegetable intake (g day⁻¹)</td>
<td>192/258</td>
<td>75.4 (30.0)</td>
<td>78.8 (29.6)</td>
<td>0.123</td>
</tr>
<tr>
<td>Child report of vegetable intake (g day⁻¹)</td>
<td>209/323</td>
<td>99.1 (47.6)</td>
<td>102.5 (42.2)</td>
<td>0.288</td>
</tr>
<tr>
<td><strong>Children of non-Western ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent report of fruit intake (pieces day⁻¹)</td>
<td>158/87</td>
<td>1.21 (0.82)</td>
<td>1.40 (0.95)</td>
<td><strong>0.016</strong></td>
</tr>
<tr>
<td>Child report of fruit intake (pieces day⁻¹)</td>
<td>251/113</td>
<td>1.97 (1.14)</td>
<td>1.80 (1.01)</td>
<td><strong>0.022</strong></td>
</tr>
<tr>
<td>Parent report of vegetable intake (g day⁻¹)</td>
<td>153/83</td>
<td>77.3 (43.9)</td>
<td>85.7 (45.7)</td>
<td><strong>0.033</strong></td>
</tr>
<tr>
<td>Child report of vegetable intake (g day⁻¹)</td>
<td>227/116</td>
<td>120.6 (66.3)</td>
<td>120.2 (64.5)</td>
<td>0.936</td>
</tr>
</tbody>
</table>

SD – standard deviation.
* Estimated by t-test for paired samples.
† Estimated by t-test for independent samples.
**TABLE 5.3:** Indicators of effects of the intervention regarding fruit and vegetable intake from multilevel regression analyses conducted on child-reports as well as parent-reports, separately for children of Dutch and of non-Western ethnicity

<table>
<thead>
<tr>
<th>Primary outcomes *</th>
<th>N</th>
<th>β</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Children of Dutch ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent report of fruit intake (pieces day⁻¹)</td>
<td>455</td>
<td>0.12</td>
<td>-0.01 – 0.24</td>
</tr>
<tr>
<td>Child report of fruit intake (pieces day⁻¹)</td>
<td>519</td>
<td>0.23</td>
<td><strong>0.07 – 0.39</strong></td>
</tr>
<tr>
<td>Parent report of vegetable intake (g day⁻¹)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls ♂</td>
<td>238</td>
<td>8.03</td>
<td>-1.50 – 17.55</td>
</tr>
<tr>
<td>Boys</td>
<td>211</td>
<td>1.23</td>
<td>-6.70 – 9.16</td>
</tr>
<tr>
<td>Child report of vegetable intake (g day⁻¹)</td>
<td>504</td>
<td>5.06</td>
<td>-2.29 – 12.41</td>
</tr>
<tr>
<td><strong>Children of non-Western ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent report of fruit intake (pieces day⁻¹)</td>
<td>234</td>
<td>0.09</td>
<td>-0.16 – 0.35</td>
</tr>
<tr>
<td>Child report of fruit intake (pieces day⁻¹)</td>
<td>301</td>
<td>0.14</td>
<td>-0.11 – 0.39</td>
</tr>
<tr>
<td>Parent report of vegetable intake (g day⁻¹)</td>
<td>226</td>
<td>2.78</td>
<td>-10.03 – 15.59</td>
</tr>
<tr>
<td>Child report of vegetable intake (g day⁻¹)</td>
<td>287</td>
<td><strong>20.68</strong></td>
<td><strong>7.63 – 33.72</strong></td>
</tr>
</tbody>
</table>

* indicates difference in primary outcome in the intervention compared with the control group; CI - confidence interval.

* Analyses are adjusted for children's age, (gender), education level of the parents, region of residence of the children, and baseline levels of fruit or vegetable consumption.

† A significant interaction for gender between the children of Dutch ethnicity (P-value=0.078).

**Determinants of fruit intake (secondary outcomes)**

*Children of Dutch ethnicity*

At baseline, 79% of the parents of children of Dutch ethnicity reported that their child liked fruit or liked fruit very much. This proportion did not differ between the intervention and control groups at baseline or follow-up (see TABLE 5.4). However, when taking potential confounders into account, a significant intervention effect was observed. According to the parent data (but not the child data), boys in the intervention group were less likely to have decreased their liking of fruit between baseline and follow-up (see TABLE 5.5).

The unadjusted analyses showed an increase in knowledge of the recommendations for fruit intake in the intervention group (see TABLE 5.4), but no effect on knowledge of recommended intake levels was observed in the adjusted analyses (see TABLE 5.5). No other effects on the determinants were observed (see TABLE 5.5).
Children of non-Western ethnicity
At baseline, 75% of the parents in this subgroup reported that their child liked fruit or liked fruit very much. According to the parent data no significant differences for the determinants of fruit intake were observed between intervention and control groups (see TABLE 5.4). We only observed an increased accessibility of fruit in the control group at follow-up.

According to the child data, the unadjusted results indicated that the intervention group significantly increased their knowledge of recommendations for fruit intake, were more often allowed to take fruit without asking and also perceived higher fruit availability at home at follow-up (see TABLE 5.4).

Adjusted analyses on the parent data showed a significant effect for taste preference only. Children in the intervention group were less likely to have decreased their preferences for fruit between baseline and follow-up. In the adjusted child data significant effects were found for perceived accessibility (see TABLE 5.5).
### TABLE 5.4: Determinants of fruit intake at baseline and at follow-up in the intervention and the control group conducted on parent and child-reported data, separately for children of Dutch and of non-Western ethnicity

<table>
<thead>
<tr>
<th>Secondary outcomes – FRUIT</th>
<th>Intervention Group</th>
<th>Control Group</th>
<th>Comparison between groups†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Follow-up</td>
<td>P-value*</td>
</tr>
<tr>
<td>N %</td>
<td>N %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Children of Dutch ethnicity (parent data)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taste of the child</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don’t/like a few</td>
<td>44 22.7</td>
<td>36 18.6</td>
<td><strong>0.006</strong></td>
</tr>
<tr>
<td>Like fruit</td>
<td>88 45.3</td>
<td>83 42.7</td>
<td></td>
</tr>
<tr>
<td>Enjoy fruit very much</td>
<td>62 32.0</td>
<td>75 38.7</td>
<td></td>
</tr>
<tr>
<td>Knowledge of the parent about the recommendations for fruit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Too little</td>
<td>18 9.3</td>
<td>23 11.9</td>
<td>0.831</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>55 28.4</td>
<td>48 24.7</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>121 62.3</td>
<td>123 63.4</td>
<td></td>
</tr>
<tr>
<td>Is the child allowed to take fruit without asking?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>19 9.8</td>
<td>23 11.9</td>
<td>0.655</td>
</tr>
<tr>
<td>Sometimes</td>
<td>29 14.9</td>
<td>25 12.9</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>146 75.3</td>
<td>146 75.2</td>
<td></td>
</tr>
<tr>
<td>Fruit available at home</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never / sometimes</td>
<td>10 5.2</td>
<td>5 2.6</td>
<td>0.059</td>
</tr>
<tr>
<td>Usually</td>
<td>183 94.8</td>
<td>189 97.4</td>
<td></td>
</tr>
<tr>
<td>Children of Dutch ethnicity (Child data)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taste of the child</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don’t/like a few</td>
<td>2 0.9</td>
<td>2 0.9</td>
<td>0.701</td>
</tr>
<tr>
<td>Like fruit</td>
<td>60 26.4</td>
<td>57 25.1</td>
<td></td>
</tr>
<tr>
<td>Enjoy fruit very much</td>
<td>165 72.7</td>
<td>168 74.0</td>
<td></td>
</tr>
<tr>
<td>Knowledge of the child about the recommendations for fruit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Too little</td>
<td>68 31.6</td>
<td>52 23.0</td>
<td><strong>0.004</strong></td>
</tr>
<tr>
<td>Satisfactory</td>
<td>65 30.2</td>
<td>67 29.6</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>82 38.2</td>
<td>107 47.4</td>
<td></td>
</tr>
<tr>
<td>Is the child allowed to take fruit without asking?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>29 12.8</td>
<td>20 8.8</td>
<td><strong>0.007</strong></td>
</tr>
<tr>
<td>Sometimes</td>
<td>61 27.0</td>
<td>48 21.1</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>136 60.2</td>
<td>159 70.1</td>
<td></td>
</tr>
<tr>
<td>Fruit available at home</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never /sometimes</td>
<td>72 31.7</td>
<td>42 18.5</td>
<td><strong>&lt;0.001</strong></td>
</tr>
<tr>
<td>Usually</td>
<td>155 68.3</td>
<td>185 81.5</td>
<td></td>
</tr>
</tbody>
</table>
Children of non-Western ethnicity (parent data)

<table>
<thead>
<tr>
<th>Taste of the child</th>
<th>Don't/like a few</th>
<th>Like fruit</th>
<th>Enjoy fruit very much</th>
<th>Knowledge of the parent about the recommendations for fruit</th>
<th>Too little</th>
<th>Satisfactory</th>
<th>Good</th>
<th>Is the child allowed to take fruit without asking?</th>
<th>Yes</th>
<th>No</th>
<th>Sometimes</th>
<th>( p )</th>
<th>Fruit available at home</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Too little</td>
<td>19</td>
<td>12.3</td>
<td>18</td>
<td>11.5</td>
<td>0.267</td>
<td>8</td>
<td>9.3</td>
<td>8</td>
<td>9.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Satisfactory</td>
<td>57</td>
<td>36.8</td>
<td>49</td>
<td>31.2</td>
<td>0.643</td>
<td>31</td>
<td>36.0</td>
<td>34</td>
<td>39.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Good</td>
<td>79</td>
<td>50.9</td>
<td>90</td>
<td>57.3</td>
<td>0.775</td>
<td>47</td>
<td>54.7</td>
<td>45</td>
<td>51.7</td>
</tr>
<tr>
<td>Is the child allowed to take fruit without asking?</td>
<td>No</td>
<td>1.9</td>
<td>4</td>
<td>2.5</td>
<td>0.137</td>
<td>3</td>
<td>3.5</td>
<td>4</td>
<td>4.7</td>
<td><strong>0.041</strong></td>
<td>0.480</td>
<td>0.526</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sometimes</td>
<td>33</td>
<td>21.0</td>
<td>22</td>
<td>13.9</td>
<td>0.406</td>
<td>22</td>
<td>25.9</td>
<td>9</td>
<td>10.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>121</td>
<td>77.1</td>
<td>132</td>
<td>83.6</td>
<td>0.458</td>
<td>60</td>
<td>70.6</td>
<td>72</td>
<td>84.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit available at home</td>
<td>Never / sometimes</td>
<td>14</td>
<td>8.9</td>
<td>9</td>
<td>5.8</td>
<td>0.439</td>
<td>7</td>
<td>8.0</td>
<td>6</td>
<td>7.0</td>
<td><strong>0.055</strong></td>
<td><strong>0.816</strong></td>
<td><strong>0.728</strong></td>
</tr>
<tr>
<td></td>
<td>Usually</td>
<td>143</td>
<td>91.1</td>
<td>145</td>
<td>94.2</td>
<td>0.864</td>
<td>80</td>
<td>92.0</td>
<td>80</td>
<td>93.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Children of non-Western ethnicity (Child data)

<table>
<thead>
<tr>
<th>Taste of the child</th>
<th>Don't/like a few</th>
<th>Like fruit</th>
<th>Enjoy fruit very much</th>
<th>Knowledge of the child about the recommendations for fruit</th>
<th>Too little</th>
<th>Satisfactory</th>
<th>Good</th>
<th>Is the child allowed to take fruit without asking?</th>
<th>Yes</th>
<th>No</th>
<th>Sometimes</th>
<th>( p )</th>
<th>Fruit available at home</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Too little</td>
<td>75</td>
<td>31.8</td>
<td>54</td>
<td>22.0</td>
<td>0.017</td>
<td>32</td>
<td>29.6</td>
<td>33</td>
<td>29.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Satisfactory</td>
<td>85</td>
<td>36.0</td>
<td>91</td>
<td>37.0</td>
<td>0.982</td>
<td>31</td>
<td>28.7</td>
<td>32</td>
<td>28.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Good</td>
<td>76</td>
<td>32.2</td>
<td>101</td>
<td>41.0</td>
<td>0.010</td>
<td>45</td>
<td>41.7</td>
<td>46</td>
<td>41.5</td>
</tr>
<tr>
<td>Is the child allowed to take fruit without asking?</td>
<td>No</td>
<td>3.6</td>
<td>3</td>
<td>1.2</td>
<td><strong>0.010</strong></td>
<td>6</td>
<td>5.4</td>
<td>5</td>
<td>4.4</td>
<td><strong>0.022</strong></td>
<td><strong>&lt;0.001</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sometimes</td>
<td>40</td>
<td>16.1</td>
<td>31</td>
<td>12.4</td>
<td>0.439</td>
<td>31</td>
<td>27.7</td>
<td>31</td>
<td>27.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>200</td>
<td>80.3</td>
<td>215</td>
<td>86.4</td>
<td>0.864</td>
<td>75</td>
<td>66.9</td>
<td>77</td>
<td>68.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit available at home</td>
<td>Never / sometimes</td>
<td>68</td>
<td>27.3</td>
<td>49</td>
<td>19.6</td>
<td>0.009</td>
<td>26</td>
<td>23.2</td>
<td>25</td>
<td>22.1</td>
<td>0.827</td>
<td>0.412</td>
<td>0.580</td>
</tr>
<tr>
<td></td>
<td>Usually</td>
<td>181</td>
<td>72.7</td>
<td>201</td>
<td>80.4</td>
<td>0.864</td>
<td>86</td>
<td>76.8</td>
<td>88</td>
<td>77.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Estimated by paired Wilcoxon test (paired categorical data).
† Estimated by \( \chi^2 \) test (independent categorical data).
### TABLE 5.5: Indicators of effects of the intervention regarding determinants of fruit intake from multilevel regression analyses conducted on parent and child-reported data, separately for children of Dutch and of non-Western ethnicity

<table>
<thead>
<tr>
<th>Secondary outcomes</th>
<th>Parent report</th>
<th>Child report</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>OR*</td>
</tr>
<tr>
<td><strong>Children of Dutch ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taste of the child - boys (+girls)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Stable high – increased (2)</td>
<td>146</td>
<td>1.00</td>
</tr>
<tr>
<td>- Stable low (1)</td>
<td>40</td>
<td>0.64</td>
</tr>
<tr>
<td>- Decreased (0)</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Taste of the child - girls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Stable high – increased (2)</td>
<td>183</td>
<td>1.00</td>
</tr>
<tr>
<td>- Stable low (1)</td>
<td>22</td>
<td>1.14</td>
</tr>
<tr>
<td>- Decreased (0)</td>
<td>34</td>
<td>0.69</td>
</tr>
<tr>
<td>Knowledge about the recommendations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Stable high – increased (2)</td>
<td>358</td>
<td>1.00</td>
</tr>
<tr>
<td>- Stable low (1) + decreased (0)</td>
<td>91</td>
<td>1.43</td>
</tr>
<tr>
<td>- Decreased (0)</td>
<td></td>
<td>142</td>
</tr>
<tr>
<td>Is the child allowed to take fruit without asking? - boys (+ all children)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Stable high – increased (2)</td>
<td>366</td>
<td>1.00</td>
</tr>
<tr>
<td>- Stable low (1)</td>
<td>38</td>
<td>1.73</td>
</tr>
<tr>
<td>- Decreased (0)</td>
<td>48</td>
<td>1.43</td>
</tr>
<tr>
<td>Is the child allowed to take fruit without asking? - girls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Stable high – increased (2)</td>
<td>177</td>
<td>1.00</td>
</tr>
<tr>
<td>- Stable low (1)</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>- Decreased (0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit available at home</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Stable high – increased (2)</td>
<td>434</td>
<td>1.00</td>
</tr>
<tr>
<td>- Stable low (1) – decreased (0)</td>
<td>13</td>
<td>0.94*</td>
</tr>
<tr>
<td><strong>Children of non-Western ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taste of the child</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Stable high – increased (2)</td>
<td>154</td>
<td>1.00</td>
</tr>
<tr>
<td>- Stable low (1)</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>- Decreased (0)</td>
<td>45</td>
<td>0.65</td>
</tr>
<tr>
<td>Knowledge about the recommendations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Stable high – increased (2)</td>
<td>172</td>
<td>1.00</td>
</tr>
<tr>
<td>- Stable low (1) + decreased (0)</td>
<td>58</td>
<td>0.74</td>
</tr>
<tr>
<td>- Decreased (0)</td>
<td></td>
<td>73</td>
</tr>
</tbody>
</table>
Chapter 5

Is the child allowed to take fruit without asking?

<table>
<thead>
<tr>
<th>Stabilisation &amp; Change</th>
<th>Number of children</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable high – increased (2)</td>
<td>198</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>Stable low (1)</td>
<td>15</td>
<td>1.48</td>
<td>0.41 – 5.34</td>
</tr>
<tr>
<td>Decreased (0)</td>
<td>18</td>
<td>1.42</td>
<td>0.47 – 4.25</td>
</tr>
<tr>
<td>Stable high – increased (2)</td>
<td>237</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>Stable low (1)</td>
<td>32</td>
<td>0.25</td>
<td>0.11 – 0.57</td>
</tr>
<tr>
<td>Decreased (0)</td>
<td>23</td>
<td>0.58</td>
<td>0.20 – 1.70</td>
</tr>
</tbody>
</table>

Fruit available at home – boys (+ all children)

<table>
<thead>
<tr>
<th>Stabilisation &amp; Change</th>
<th>Number of children</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable high – increased (2)</td>
<td>86</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>Stable low (1) – decreased (0)</td>
<td>6</td>
<td>0.30**</td>
<td>0.05 – 1.83*</td>
</tr>
<tr>
<td>Stable high – increased (2)</td>
<td>240</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>Stable low (1) – decreased (0)</td>
<td>57</td>
<td>0.54</td>
<td>0.28 – 1.03</td>
</tr>
</tbody>
</table>

Fruit available at home – girls

<table>
<thead>
<tr>
<th>Stabilisation &amp; Change</th>
<th>Number of children</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable high – increased (2)</td>
<td>129</td>
<td>1.00</td>
<td>-</td>
</tr>
<tr>
<td>Stable low (1) – decreased (0)</td>
<td>8</td>
<td>1.47</td>
<td>0.24 – 9.13</td>
</tr>
</tbody>
</table>

Analyses are adjusted for children’s age, gender, region of residence of the children, and educational level of the parents.

* OR – odds ratio for comparison with the control group; CI – confidence interval.

** Not adjusted for educational level of the parents, because of empty cells

† Parents of native Dutch children → an interaction between intervention x gender (P = 0.062) in the ‘decreased’ group was found for taste

‡ Dutch native children → an interaction between intervention x gender (P = 0.009) in the ‘decreased’ group was found for accessibility

¶ Parents of non-Western ethnicity children → an interaction between intervention x gender (P = 0.054) was found for availability
DISCUSSION

The present study indicates that the Schoolgruiten Project had a significant effect on the fruit intake of children of Dutch ethnicity and on vegetable intake of children of non-Western ethnicity, but these effects were found only in analyses based on the child-reported data.

A Danish study with a follow-up period of 5 weeks also showed positive effects for fruit intake. However, in the Danish study parents had to pay for the daily school F&V. Positive effects of free school F&V delivery were reported by Bere et al. based on a study conducted in Norway; the intervention group reported an increase of approximately 0.9 portions of F&V at 10-months’ follow-up.

The effects of the Schoolgruiten Project fall within that same range. The Schoolgruiten Project was initiated outside an academic centre; it was planned, developed and implemented by a public-private partnership of the Netherlands Nutrition Centre Foundation with the promotion office of the Dutch F&V producers. This partnership did try to combine intervention strategies that were tailored to important mediators of F&V intake in primary school children, but because of time constraints was not able to work carefully according to established planning models, as was done, for example, in the similar Pro Children intervention.

A disadvantage of the research design applied in the present study is that randomisation was not possible, since the Dutch government had indicated the intervention cities. Although our analyses indicated very few baseline differences between the intervention and control groups, the fact that schools were not randomly allocated may have introduced bias. Another bias may have occurred due to some selective dropout. However loss to follow-up was not a consequence of an autonomous decision of the child, but was primarily caused by dropout of five schools, and in some cases based on parental decisions.

Evaluation of school-based healthful nutrition promotion interventions should be based on accurate and valid assessments of intake levels and mediators of intakes. Collecting accurate intake data based on observations or biomarkers is often possible in smaller scale, carefully controlled efficacy studies, but not in larger-scale studies in real-life settings. Collecting blood samples in children introduces bias because of low participation rates. Food frequency questionnaires are therefore generally used. Although these questionnaires rely on participants’ memory and cognition, which may influence the accuracy of the reported intake, this bias is believed to be the same in the control as in the intervention group.
The Schoolgruiten intervention aimed at increasing availability and accessibility of F&V and we indeed found that perceived accessibility was improved in the intervention group at follow-up, according to the data of the children of non-Western ethnicity. We also observed some favourable positive changes in the intervention group for taste preference. Unfortunately, we found no effects on knowledge of recommended intake levels, although the school curriculum did address these recommendations. This may be due to the fact that the curriculum was not adopted and implemented by all intervention schools. The curriculum materials were used at least once by only about 40% of the intervention schools.

Since earlier research had indicated that children from non-Western ethnicity in the Netherlands have higher intake levels and correlates of F&V intakes, we explored differential effects of the intervention according to ethnicity. We hypothesised that children of non-Western ethnicity would profit less from the intervention than the children of Dutch ethnicity. This hypothesis was supported only for fruit intake, while for vegetables the intervention appeared to be somewhat more effective among the children of non-Western ethnicity. Since ethnic differences in the Netherlands are strongly confounded by educational differences, ethnic differences often disappear if education is taken into account. Nevertheless, ethnicity is of course much more than education. As a secondary analysis we also conducted a priori stratification according to education, testing effects separately for children from higher and lower educated parents, while adjusting for ethnicity. In these analyses, no differences in effects were found (data not shown), indicating that the observed differences between the children of Dutch ethnicity and the children of non-Western ethnicity were not the result of differences in educational level of the parents.

All effects regarding usual intake levels were found in the child-reported data. These effects were not confirmed in analyses of the parent-report data. This may partly be due to power issues, since parent-report data were available for fewer children. The parent-reported mean F&V intakes at baseline and follow-up for the intervention and control groups (see TABLE 5.2) do indicate that the mean intake levels between baseline and follow-up were more positive in the intervention group. Parental reports are considered useful because two thirds of the schoolchildren eat at home during the lunch break in The Netherlands, and parents are responsible for availability and accessibility of foods at home. When the children stay at school, they bring their own lunch and snacks, as no school meals are offered and no food can be obtained from vending machines or otherwise, and children are not allowed to leave the school or schoolyard during school hours. Nevertheless, it must be realised that the parents did not directly observe the main part of the present intervention: the distribution of F&V on two schooldays
per week. It may therefore be that the child reports were more sensitive to changes induced by this particular intervention. On the other hand, since the children were much more intensively exposed to intervention activities than the parents, it may also be that the children in the intervention group were more likely to give social desirable answers, and that this led to higher intake reports compared with the control group.

**CONCLUSION**

The present study provides some evidence that the Schoolgruiten intervention was effective in increasing fruit intake of children of Dutch ethnicity and increasing the vegetable intake of children of non-Western ethnicity (according the child data). In addition, we observed positive intervention effects for taste preference and increased accessibility among the children of non-Western ethnicity.

**REFERENCE LIST**


47, 242-250.

Long-term effects of the Dutch Schoolgruiten Project - promoting fruit and vegetable consumption among primary schoolchildren

Paper published as:
ABSTRACT

Objectives: To evaluate the long-term effects of the Schoolgruiten Project, a Dutch primary school-based intervention providing free fruit and vegetable (F&V). In addition, we assessed whether children’s appreciation of the project mediated these intervention effects.

Design & methods: Participating schoolchildren (mean age 9.9 years at baseline) and their parents completed parallel questionnaires at baseline, at 1-year and at 2-year follow-up, including questions on usual F&V intake of the child, potential behavioural determinants, and their appreciation of the project and general demographics. Primary outcomes were usual F&V intakes as assessed by parent and child self-reported food frequency measures. Secondary outcome measures were taste preference, knowledge of daily recommendations, availability and accessibility for fruit intake. Multilevel linear regression analyses were used to assess differences at second follow-up adjusted for baseline values between control and intervention groups.

Subjects: Reports were available for 346 intervention children (148 parents) and 425 control children (287 parents).

Results: Both children and parent reports indicated that the intervention group reported a significantly higher fruit intake at 2-year follow-up (difference, servings/d: 0.15; 95% CI 0.004–0.286 for child reports; 0.19; 95% CI 0.030–0.340 for parent reports). No significant effects on vegetable intake were observed. Significant positive intervention effects were also found for knowledge of fruit recommendations among boys. Some evidence was found for partial mediation analyses of the effects on fruit intake.

Conclusion: The present study indicates that the Schoolgruiten scheme was effective in increasing children’s fruit intake and that appreciation of the project partially mediated this effect.
INTRODUCTION

Since most children in Western countries, including the Netherlands, do not comply with recommendations for fruit and vegetable (F&V) intake, several interventions promoting F&V consumption have been implemented.

One of the Dutch interventions is the Schoolgruiten Project. Schoolgruiten is a Dutch acronym for ‘school fruits and vegetables’ and is the largest-scale free F&V scheme for Dutch primary-school children. The main strategy of this project is to improve accessibility of F&V at school by providing a serving of fruit or vegetable for free to all children twice weekly. The Schoolgruiten Project is meant to grow into a nationwide campaign for primary schoolchildren, but started with a pilot phase in which the intervention was tested in a controlled design, to inform further improvement of the intervention or justify further implementation. Effect evaluation after one-year follow-up showed mixed results, i.e. a significant difference in vegetable intake (difference of 20.7 g/day) for children of non-Western ethnicity and a significant difference in fruit intake for children of Dutch ethnicity (difference of 0.23 pieces/day), both based on child reports. No significant effects on intake were observed based on parent reports. Significant positive intervention effects were also found for perceived accessibility among children of non-Western ethnicity, and for parent-reported taste preference of their child among children of non-Western ethnicity and among boys of Dutch ethnicity.

Nutrition behavioural change interventions such as Schoolgruiten can only have an impact on health if effects are maintained or improved over time and longer-term evaluations are therefore warranted. Furthermore, to inform future intervention schemes it is of additional importance to explore possible mediators of intervention effects, i.e. to identify effect-enhancing characteristics of the intervention. Previous research indicated that children’s appreciation of the project is associated with intervention effects.

The current study assessed the two-year follow-up effects of the Schoolgruiten F&V scheme on intake and potential behavioural determinants (knowledge of recommended intake levels, taste preferences, availability and accessibility of F&V at home), and explored whether children’s appreciation of the project mediated these intervention effects. We hypothesized that the children of the intervention group would have higher F&V intakes and more positive scores on the main determinants of F&V than the children of the control group. Furthermore, we hypothesized that children in the intervention group would report higher appreciation for F&V-promoting projects than children in the control group and, additionally, that children’s appreciation of the project would mediate the intervention effects.
METHODS

The Schoolgruiten Project
Since earlier studies and reviews indicated that taste preferences, availability and accessibility are important determinants of F&V consumption among children, and because intakes should be promoted through changes in such presumed mediators, the main strategies within the Schoolgruiten Project targeted these factors. The main component of the Schoolgruiten Project was an F&V scheme improving availability, accessibility and exposure of F&V at school. The children in the intervention group received a piece of fruit or ready-to-eat vegetables (cherry tomatoes, baby carrots) for free twice a week during a fruit break. The aim of the Schoolgruiten Project was that all children eat the piece of fruit or vegetable together in their own classroom. Apart from increasing availability and accessibility, this F&V scheme was also supposed to increase the children’s exposure to F&V. Repeated exposure is an important determinant of taste preferences.

Additionally, a school curriculum, developed and carefully pre-tested by the Netherlands Nutrition Centre Foundation, aimed at increasing knowledge and skills related to F&V consumption, was offered to the intervention schools. The schools were not obliged to use this curriculum, but they were strongly encouraged to do so.

Recruitment of the schools and study sample
The Schoolgruiten Project was implemented in seven cities in the Netherlands. These cities were indicated by the Dutch ministry of Public Health, Welfare and Sport. Because of time and financial constraints only two of these cities were included in the evaluation study. These were one big city (The Hague) in the western part of the Netherlands and a smaller town (Almelo) in the eastern part. Therefore, these cities represent different parts of the Netherlands and have very distinct characteristics, The Hague being a major city while Almelo has more rural characteristics.

The design of the evaluation study was quasi experimental, with a pre- and post-test, and an intervention and control group. Since the intervention cities were decided upon by the authorities, no randomisation was possible. The Schoolgruiten research group selected three control cities: Zoetermeer and Leidschendam close to The Hague, and Hengelo, which is close to Almelo. In the western region it was necessary to select two control cities in order to recruit enough children.

All fourth grades (9-10 years) from primary schools in the five cities were eligible for participation at baseline, and schools were randomly approached by telephone and invited to participate in this survey. Recruitment ended when fifty-five primary schools
had agreed to participate in the survey, of which thirty-one were intervention schools and twenty-four were control schools, ensuring a sample of at least 600 children of the 4th grade in the intervention as well as in the control group. For one city (Hengelo) records were kept to assess school willingness to participate. Sixteen schools were invited to participate in that city of which half agreed immediately, four refused and another four schools had to consult their external school board before confirming participation. Only the eight schools that agreed immediately were included in the study. Similar procedures and rates of agreement were found in the other cities. The baseline survey was conducted prior to the start of the intervention. First follow-up among the same children was exactly one year later and second follow-up was conducted exactly two years later. The baseline survey was conducted in The Hague, Zoetermeer and Leidschendam (western region) in the spring of 2003 and in Almelo and Hengelo (eastern region) in the autumn of 2003. For this study both children as well as their parents completed questionnaires about the child’s intake, potential determinants, general demographics and their general opinion about the Schoolgruiten Project.

**Procedure**

Children completed the questionnaire within one school hour guided by their own teacher in their classroom, based on a written administration protocol provided by the research staff. The children brought home a parent questionnaire to be completed preferably by the parent usually taking care of the child’s meals. The children got a small gift when they returned the completed parent questionnaire. All fourth graders who were present on the day and hour of administration completed the questionnaires at baseline, (1328 children, response rate of 100%; 1070 parents, response rate of 81%).

Five schools were not willing to participate any longer at first follow-up, resulting in fewer children (n=1140, response rate of 86%) and parents (n=931, response rate of 70%). Six schools were no longer willing to participate at second follow-up, again reducing the number of children (n=792, response rate of 60%) and parents (n=431, response rate of 32%).

Finally, a total of 346 intervention 425 control children had valid self-reported data for all three measurements and were included for analyses. Children with valid self-reported data on fruit and/or vegetable intake at baseline but not at first or at second follow-up were considered as dropouts. Dropout was due to the loss of five schools at first follow-up (n=112) and the loss of six schools at second follow-up (n=91) and because children moved to other places or schools, did not graduate to the next grade, were sick on the
day of administration at first (n=194) or at second follow-up (n=115), or had missing F&V reports at first (n=23) or at second follow-up (n=22).

Regarding parents, data were available for 148 intervention parents and 287 control parents. Dropout was due to the loss of five schools at first follow-up (n=105) and the loss of six schools at second follow-up (n=90), parents who moved, had a child who did not graduate to the next grade or who was sick at the day of administration, and parents who refused to complete the questionnaire at first (n=218) or second follow-up (n=218), or had missing F&V reports at first (n=2) or second follow-up (n=2).

Responses were treated anonymously and confidentiality was ensured. The Schoolgruiten study was approved by the Netherlands Organization for Health Research and Development (ZonMw) Program for Prevention and by The World Cancer Research Fund.

**Questionnaires**

Separate questionnaires for children and parents were developed, both based on and thus similar to the validated questionnaire of the Pro Children Study. By parallel questions in the two questionnaires, the usual intake of F&V among the children was assessed with the Pro Children food frequency questions. Potential determinants of F&V, such as taste preference, knowledge of recommendations, accessibility, and availability, were assessed with questions similar to those used in the Pro Children Study.

The parent questionnaire also included questions on the parent’s country of birth, level of education, age, child’s age and number of siblings. Information on the country of birth of parents was used to make distinctions between children of Dutch, non-Western, and non-Dutch Western ethnicity. Educational level was divided into three categories based on the highest educational level of one of the parents (primary school or pre-vocational training=low; high school or medium level vocational training=medium; high level vocational training, college or university training=high). A more detailed description of the questions and answer alternatives of both questionnaires has been published previously.

**Appreciation of the project**

To assess children's appreciation of the project or of a F&V-promoting project in general, one open question was included in the child questionnaire in both the intervention and the control group. At baseline the question was: ‘Do you think it is a good idea for ready-to-eat F&V to be provided at your school?’ In the control group the question was the same at both follow-ups, but in the intervention group the question was adapted at both follow-ups to: ‘What do you think about the project Schoolgruiten?’ The answers were re-coded to a three-point scale: negative (-1), neutral (0) and positive (+1).
Statistical methods
Since in the present project both child- and parent-report data were available and it is not clear which data are most valid and sensitive for evaluation of school-based interventions, all analyses were performed on both data sets. We used a complete cases design and therefore included only children and parents who had valid fruit intake or vegetable intake on all three measurements. Quitting the study was not a conscious decision of the child, but a result of circumstances not influenced by the child, e.g. moving to another school or town, not graduating to the next grade or a decision of the school board to quit the study.

Selective dropout bias and selective parent participation bias were assessed by logistic regression analyses with gender, ethnicity, parent educational level, region of residence of the children (categorical variables) and intake of fruit or vegetable at baseline (continuous variables) as independent variables and dropout (1=yes, 0=no) as the dependent variable. Means, standard deviations and percentages were calculated to describe the key variables.

To describe unadjusted outcomes, paired sample t tests, t test for independent samples, paired Wilcoxon tests and $\chi^2$ tests were used. To assess the adjusted effect of the intervention regarding the primary outcomes, multilevel linear regression analyses were performed to compare fruit or vegetable intakes at second follow-up (dependent variable) between intervention and control groups (dichotomous independent variable, scored as 1 and 0, respectively). A multilevel analysis was used to take into account that effects may cluster within schools/classes. Analyses were further adjusted for children's age, gender, parents' education level, region of residence and baseline intake levels. The estimated regression coefficient reflects the adjusted difference in fruit/vegetable consumption at second follow-up between the intervention and control group. The residuals of the regression analyses were checked for normality and were considered as acceptable.

Effect modification by gender, ethnicity, educational level and region of residence was assessed by including gender x group, ethnicity x group, educational level x group and region of residence x group interaction terms in the model. When these terms approached significance (P < 0.10), analyses were stratified.

Intervention effects on the main determinants of F&V intake, which were all categorical variables, were assessed by means of multilevel multinomial regression analyses, as suggested by Twisk & Proper. Therefore, newly categorical variables were constructed, with three categories which were defined by the scores on baseline and second follow up. The categories were: the ‘stable high and increased’ group (= the reference group (0)), the ‘stable low’ group (1) and the ‘decreased’ (2) group. Again, group (intervention=1,
control=0) was the independent variable and the analyses were adjusted for children's age, gender, education level of the parents and region of residence. The estimated odds ratios reflect the odds for the intervention group compared with the control group of being in the specific category compared with being in the reference category (=stable high/increased). When cells for the multinomial logistic regression analyses include a small number, no reliable odds ratios can be estimated. Five percent of the total sample or less was considered as a small number and in that case three categories were merged into two categories to solve this problem.

Regression analyses were further used to assess whether the intervention effects were mediated by the appreciation of the project. Several authors describe criteria that must be met for a variable to be considered a mediator. In the present study this implied that (see FIGURE 6.1): (i) the independent variable (intervention) must be independently associated with the presumed mediator (appreciation of the project; path A); (ii) the presumed mediator must be independently associated with the dependent variable (F&V intake; path B); (iii) the intervention must be associated with F&V intake (path C); and (iv) the association between the intervention and F&V intake must decrease substantially when adjustment is made for appreciation of the project. To determine the associations between the potential mediator and F&V intake, a mediation model, adjusted for the intervention group, was applied. For appreciation of a F&V promotion project, we used the scores at second follow-up and we adjusted for the scores at baseline in this model. In this regression model, dummies were used for all scores of the appreciation a F&V promotion project.

The descriptive and unadjusted data analyses were performed using the SPSS statistical software package version 14.0 (SPSS Inc., Chicago, IL, USA, 1999). The multilevel analyses were conducted using MLwiN software Version 2.01. The significance level was set at P < 0.05.
RESULTS

Dropout and non-participating parents
Owing to the loss of eleven schools (eight intervention schools and three control schools), selective dropout was found for children in the intervention group (child data: OR=1.99, 95% CI 1.50-2.65; parent data: OR=2.50, 95% CI 1.89-3.31), for those residing in the eastern region (child data: OR=2.11, 95% CI 1.53-2.92), for boys (child data: OR=1.42, 95% CI 1.09-1.87; parent data: OR=1.76, 95% CI 1.34-2.30) and for parents of children of a non-Western ethnicity (OR=1.40, 95% CI 1.01-1.93).

At baseline, children of non-participating parents were more likely to be in the intervention group (OR=1.79, 95% CI 1.10-2.91), to live in the western region (OR=2.33, 95% CI 1.34-4.07), to be a boy (OR=1.56, 95% CI 1.01-2.42) and have a non-Western ethnicity (OR=3.09, 95% CI 1.82-5.22). At second follow-up, the difference regarding region of residence was no longer significant, while the differences in gender (OR=1.84, 95% CI 1.40-2.43, study group (OR=4.61, 95% CI 3.45-6.17 and ethnicity (OR=1.40, 95% CI 1.01-1.94) remained.

Characteristics of the participants
As shown in TABLE 6.1, the study sample consisted of slightly more girls than boys, in the intervention as well as in the control group. The majority of the children were of native Dutch origin, in particular in the control group. At baseline, the age of all children ranged between 8.5-11.8 years; for parents this was 25.2-61.0 years.
TABLE 6.1: Characteristics of the study population at baseline (child data)

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>Intervention group</th>
<th>Control group</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean (SD) or %</td>
<td>N</td>
</tr>
<tr>
<td>Age of the children, years</td>
<td>346</td>
<td>10.1 (0.6)</td>
<td>425</td>
</tr>
<tr>
<td>Age of the parents, years</td>
<td>249</td>
<td>38.1 (5.2)</td>
<td>361</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>148</td>
<td>42.8</td>
<td>198</td>
</tr>
<tr>
<td>Girls</td>
<td>198</td>
<td>57.2</td>
<td>227</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native Dutch children</td>
<td>135</td>
<td>39.0</td>
<td>301</td>
</tr>
<tr>
<td>Children of Western ethnicity</td>
<td>18</td>
<td>5.2</td>
<td>16</td>
</tr>
<tr>
<td>Children of non-Western ethnicity</td>
<td>193</td>
<td>55.8</td>
<td>108</td>
</tr>
<tr>
<td>Educational level of the parents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>110</td>
<td>36.3</td>
<td>69</td>
</tr>
<tr>
<td>Moderate</td>
<td>108</td>
<td>35.6</td>
<td>153</td>
</tr>
<tr>
<td>High</td>
<td>85</td>
<td>28.1</td>
<td>181</td>
</tr>
<tr>
<td>Number of siblings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>26</td>
<td>8.4</td>
<td>31</td>
</tr>
<tr>
<td>1</td>
<td>129</td>
<td>41.6</td>
<td>208</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
<td>25.8</td>
<td>94</td>
</tr>
<tr>
<td>≥ 3</td>
<td>75</td>
<td>24.2</td>
<td>79</td>
</tr>
</tbody>
</table>

* As estimated by $X^2$ test (independent categorical data).

F&V intake (primary outcomes)

TABLE 6.2 shows the observed mean values for the child-reported intake of F&V, as well as the mean parent-reported intakes F&V, for the baseline measurement and for the measurement at second follow-up.

At second follow-up the unadjusted analyses showed higher child-reported fruit intake in the intervention than in the control group (see TABLE 6.2), which remained significant after adjustment for potential confounders (difference, pieces/d: 0.145, 95% CI 0.004–0.286; see TABLE 6.3). Results of the parent-reported data supported these observations (adjusted difference, pieces/d: 0.185, 95% CI 0.030–0.340; see TABLES 6.2 and 6.3).

A significance interaction ($P = 0.013$) with parental educational level was found for child-reported fruit intake, but after stratification no significant effect sizes were found in either group most likely due to lack of power (data not shown). This was also observed in the parent reported data (data not shown). According to both the child and parent reported data, the parents with a high educational level had the highest regression coefficients.

At second follow-up the children in the intervention group reported a significantly higher unadjusted vegetable intake than the children in the control group ($P = 0.025$; see TABLE 6.2), but after adjustment for the potential confounders this difference was no longer significant (see TABLE 6.3). Also for the parent-reported vegetable intake, no significant difference was observed after adjustments for the potential confounders (see TABLE 6.3).
**TABLE 6.2:** F&V intakes in the intervention and the control groups, at baseline and at second follow-up, reported by both children and their parents

<table>
<thead>
<tr>
<th>F&amp;V intakes</th>
<th>N Intervention/Control</th>
<th>Intervention group</th>
<th>Control group</th>
<th>Comparisons between groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline Mean (SD)</td>
<td>Follow-up 2 Mean (SD)</td>
<td>P-value*</td>
<td>Baseline Mean (SD)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child reports on fruit intake</td>
<td>329/398</td>
<td>1.74 (1.12)</td>
<td>1.52 (0.91)</td>
<td><strong>0.001</strong></td>
</tr>
<tr>
<td>(pieces/day)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent reports on fruit intake</td>
<td>145/285</td>
<td>1.20 (0.81)</td>
<td>1.37 (0.86)</td>
<td><strong>0.007</strong></td>
</tr>
<tr>
<td>(pieces/day)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child reports on vegetable intake</td>
<td>292/403</td>
<td>113.5 (60.3)</td>
<td>102.6 (46.3)</td>
<td><strong>0.003</strong></td>
</tr>
<tr>
<td>(g/day)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent reports on vegetable intake</td>
<td>138/275</td>
<td>74.8 (34.5)</td>
<td>83.6 (39.1)</td>
<td><strong>0.022</strong></td>
</tr>
<tr>
<td>(g/day)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* As estimated by *t* test for paired samples.
† As estimated by *t* test for independent samples.
Table 6.3: Indicators of effects of the intervention regarding F&V intake from multilevel regression analyses conducted on both child reports and their parent reports

<table>
<thead>
<tr>
<th>Primary outcomes</th>
<th>N</th>
<th>β</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child reports on fruit intake (pieces/day)</td>
<td>667</td>
<td>0.145</td>
<td>0.004 – 0.286</td>
</tr>
<tr>
<td>Parent reports on fruit intake (pieces/day)</td>
<td>423</td>
<td>0.185</td>
<td>0.030 – 0.340</td>
</tr>
<tr>
<td>Child report on vegetable intake (g/d)</td>
<td>635</td>
<td>0.67</td>
<td>-7.00 – 8.34</td>
</tr>
<tr>
<td>Parent reports on vegetable intake (g/d)</td>
<td>407</td>
<td>0.56</td>
<td>-7.72 – 8.85</td>
</tr>
</tbody>
</table>

* Analyses are adjusted for children’s age, gender, ethnicity, education level of the parents, region of residence of the children, and baseline levels of fruit or vegetable consumption.

β indicates difference in primary outcome in the intervention as compared to the control group.
CI = confidence interval.

Determinants of fruit intake (secondary outcomes)
All analyses on determinants of fruit intake were not adjusted for children of a non-Dutch Western ethnicity because of small samples and empty cells; therefore this group was merged with the native Dutch children group.

According the child-reported data, the unadjusted results indicated that children in the intervention group were more likely to know the recommendations for fruit intake, were more often allowed to take fruit without asking and also perceived higher fruit availability at home at second follow-up compared to the control group (see Table 6.4). After adjustments and stratification, (because a significant interaction with gender, P = 0.021) a significant intervention effect was still observed among boys for knowledge of the recommendations of fruit intake. Furthermore, adjusted analyses showed that children in the intervention group in the eastern region were more likely to be in the stable low group for their preferences for fruit.

At baseline, 79% of the parents of all children reported that their child liked fruit or liked fruit very much. This proportion did not differ between the intervention and control group at baseline or at second follow-up (see Table 6.4). Although the children in the intervention group seemed to have higher taste preferences at follow-up (unadjusted analyses, see Table 6.4), adjusted analyses showed that this difference was not significant (see Table 6.5). Finally, unadjusted analyses showed that accessibility had increased in both the intervention group and the control group (see Table 6.4), which resulted in no significant intervention effect (see Table 6.5).
### TABLE 6.4: Determinants of fruit intake in the intervention and the control groups, at baseline and at second follow-up, conducted on both parent and child-reported data

<table>
<thead>
<tr>
<th>Secondary outcomes – FRUIT</th>
<th>Intervention Group</th>
<th>Control Group</th>
<th>Comparison between groups†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Follow-up 2</td>
<td>P-value*</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Taste of the child</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don’t/like a few</td>
<td>2</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>Like fruit</td>
<td>83</td>
<td>25.2</td>
<td>72</td>
</tr>
<tr>
<td>Enjoy fruit very much</td>
<td>244</td>
<td>74.2</td>
<td>255</td>
</tr>
<tr>
<td>Knowledge of the child</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>about the recommendations for fruit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Too little</td>
<td>14</td>
<td>10.3</td>
<td>21</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>104</td>
<td>73.6</td>
<td>114</td>
</tr>
<tr>
<td>Good</td>
<td>21</td>
<td>15.1</td>
<td>22</td>
</tr>
<tr>
<td>Is the child allowed to take fruit without asking?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>27</td>
<td>19.3</td>
<td>32</td>
</tr>
<tr>
<td>Sometimes</td>
<td>71</td>
<td>51.2</td>
<td>78</td>
</tr>
<tr>
<td>Yes</td>
<td>227</td>
<td>158.5</td>
<td>269</td>
</tr>
<tr>
<td>Fruit available at home</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never /sometimes</td>
<td>93</td>
<td>66.5</td>
<td>97</td>
</tr>
<tr>
<td>Usually</td>
<td>235</td>
<td>153.5</td>
<td>272</td>
</tr>
</tbody>
</table>

*As estimated by paired Wilcoxon test (paired categorical data). †As estimated by X² test (independent categorical data).
**TABLE 6.5:** Indicators of effects of the intervention regarding determinants of fruit intake from multilevel regression analyses conducted on both parent- and child-reported data

<table>
<thead>
<tr>
<th>Secondary outcomes</th>
<th>Child-reports</th>
<th>Parent-reports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>OR*</td>
</tr>
<tr>
<td>Taste of the child - western region †</td>
<td>Stable high – increased (2)</td>
<td>314</td>
</tr>
<tr>
<td></td>
<td>Stable low (1)</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Decreased (0)</td>
<td>53</td>
</tr>
<tr>
<td>Taste of the child - eastern region †</td>
<td>Stable high – increased (2)</td>
<td>260</td>
</tr>
<tr>
<td></td>
<td>Stable low (1)</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Decreased (0)</td>
<td>26</td>
</tr>
<tr>
<td>Knowledge about the recommendations – boys ‡</td>
<td>Stable high – increased (2)</td>
<td>207</td>
</tr>
<tr>
<td></td>
<td>Stable low (1)</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Decreased (0)</td>
<td>75</td>
</tr>
<tr>
<td>Knowledge about the recommendations – girls ‡</td>
<td>Stable high – increased (2)</td>
<td>254</td>
</tr>
<tr>
<td></td>
<td>Stable low (1)</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Decreased (0)</td>
<td>116</td>
</tr>
<tr>
<td>Is the child allowed to take fruit without asking? - boys (++ all children) ††</td>
<td>Stable high – increased (2)</td>
<td>262</td>
</tr>
<tr>
<td></td>
<td>Stable low (1)</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Decreased (0)</td>
<td>18</td>
</tr>
<tr>
<td>Is the child allowed to take fruit without asking? - girls ††</td>
<td>Stable high – increased (2)</td>
<td>333</td>
</tr>
<tr>
<td></td>
<td>Stable low (1)</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Decreased (0)</td>
<td>27</td>
</tr>
<tr>
<td>Fruit available at home - children of Dutch and western ethnicity (++ all children) ‡‡</td>
<td>Stable high – increased (2)</td>
<td>371</td>
</tr>
<tr>
<td></td>
<td>Stable low (1)</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Decreased (0)</td>
<td>44</td>
</tr>
<tr>
<td>Fruit available at home - children of non-western ethnicity ‡‡</td>
<td>Stable high – increased (2)</td>
<td>231</td>
</tr>
<tr>
<td></td>
<td>Stable low (1)</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Decreased (0)</td>
<td>14</td>
</tr>
</tbody>
</table>

Analyses are adjusted for children's age, gender, ethnicity, region of residence of the children, and educational level of the parents.

*OR indicates comparison with the control group.

† Children → an interaction between intervention x region (P = 0.008) in the ‘stable low’ group was found for taste

‡ Parents → an interaction between intervention x region (P = 0.030) in the ‘decreased’ group was found for taste

‡‡ Children → an interaction between intervention x ethnicity (P = 0.007) in the ‘stable low’ group was found for availability
Long term effects of a F&V intervention

Mediation analyses
Following the steps of mediation analyses, first we explored if (I) the intervention was independently associated with the appreciation of the project (path A, FIGURE 6.1). TABLE 6.6 shows that the children in the intervention group (89.7%) appreciated a F&V promoting project more than the children in the control group (62.5%). Tested in a multinomial regression model, this association appeared significant; the children of the intervention group were more likely to positively appreciate a F&V promoting project. Second, we explored if (ii) the appreciation of a F&V promoting project was independently associated with F&V intake (path B). In a regression model with two dummies for appreciation of the project, this association appeared also significant; the children who appreciated the project positively increased their fruit intake. Children's appreciation of the project was therefore further explored as a possible mediator. The last two steps (iii) explored if the intervention was associated with F&V intake (path C) and (iv) if the association between intervention and F&V intake decreased substantially when the analysis was adjusted for appreciation of a F&V promoting project. In the regression model to test these steps, the association between intervention and F&V intake appeared also significant. TABLE 6.7 shows the change in the regression coefficient for the intervention group regarding fruit intake when adjustments were made for appreciation of a F&V promoting project (step iii). Adding children's appreciation of the project to the model, the regression coefficient decreased from 0.12 to 0.04 and lost statistical significance (66.4% decrease; step iv).

TABLE 6.6: Appreciation of the project or a F&V promoting project in general, for both the intervention and the control groups, at baseline and at second follow-up

<table>
<thead>
<tr>
<th>Appreciation of the project or a F&amp;V promoting project in general</th>
<th>Intervention group</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline measurement</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Negative</td>
<td>25</td>
<td>8.1</td>
</tr>
<tr>
<td>Neutral</td>
<td>22</td>
<td>7.1</td>
</tr>
<tr>
<td>Positive</td>
<td>261</td>
<td>84.7</td>
</tr>
<tr>
<td>Second follow-up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>17</td>
<td>5.6</td>
</tr>
<tr>
<td>Neutral</td>
<td>14</td>
<td>4.6</td>
</tr>
<tr>
<td>Positive</td>
<td>271</td>
<td>89.7</td>
</tr>
</tbody>
</table>
**TABLE 6.7:** Effect of adjustment for child's appreciation of a F&V promoting project, as mediator in the association between the intervention and child-reported fruit intake at second follow-up

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Regression coefficient</th>
<th>95% CI</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unadjusted effect-size of fruit intake *</td>
<td>612</td>
<td>0.144</td>
<td>0.00 - 0.29</td>
<td></td>
</tr>
<tr>
<td>Adjusted effect-size of fruit intake **</td>
<td>612</td>
<td>0.116</td>
<td>-0.03 - 0.27</td>
<td></td>
</tr>
<tr>
<td>Adjusted for appreciation of a F&amp;V promoting project at second follow-up ***</td>
<td>612</td>
<td>0.039</td>
<td>-0.11 – 0.19</td>
<td>-66.4 ♯</td>
</tr>
</tbody>
</table>

* Unadjusted effect-size of fruit intake for 612 children; these children had a valid answer for the question about the appreciation for a F&V promoting project

** Analyses are adjusted for children's age, gender, ethnicity, region of residence of the children, and educational level of the parents

*** Analyses are adjusted for children's age, gender, ethnicity, region of residence of the children, educational level of the parents and appreciation of a F&V promoting project at second follow-up

♯ percentage of mediation by appreciation for a F&V promotion project

**DISCUSSION**

The present study indicates that the Schoolgrieten Project had a small but significant positive intervention effect on children’s fruit intake, supported by child- and parent-reported data. This is in accordance with findings of other intervention studies, such as the European Pro Children study and the Norwegian Fruit and Vegetables Makes the Marks (FVMM) project, which observed somewhat higher effect sizes 20,21 at longer-term follow-up.

Unfortunately, in the current study, the regression coefficients for vegetable intake were very small and not significant. This may be due to the difficulty of increasing vegetable intake levels in the school environment in the Netherlands. Within Dutch eating habits, vegetables are eaten at the main (evening) meal, i.e. in the home environment. No school meals are offered in Dutch primary schools, which makes promotion of vegetables consumption during school hours more difficult. In a country like Sweden, where school meals are offered and have to comply to dietary recommendations, a higher consumption of vegetables at schools is possible 22. To increase vegetable consumption among Dutch children involvement of the parents is of key importance; for example, with newsletters and homework assignments for both parents and their children to perform together 2.
Contrary to the Pro Children Study and FVMM project, the Schoolgruiten Project was initiated outside an academic centre; it was planned, developed and implemented by a public-private partnership of the Netherlands Nutrition Centre Foundation with the promotion office of the Dutch F&V producers. This partnership did try to combine intervention strategies that were tailored to important mediators of F&V intake in primary-school children. However, because of time constraints they were not able to work carefully according to established planning models for health promotion, such as the Intervention Mapping protocol, as was done for the Pro Children intervention \(^{23}\), for example.

The Schoolgruiten intervention aimed at different determinants of F&V; increasing taste preference, availability and accessibility of F&V through the free delivery of F&V at school and improving knowledge about the recommended intake levels of F&V through the school curriculum. We found that knowledge of recommended intake levels was improved among boys in the intervention group at second follow-up, probably as a result of using the curriculum materials. Unfortunately, we found no effects on perceived accessibility or home availability, while we found some effects on perceived accessibility at first (short-term effects) follow-up \(^1\). Furthermore, no effects were observed on potential behavioural determinants in the parent-reported data. Mediation analyses supported previous findings that children’s appreciation of the project was associated with the intervention effects on fruit intake. This result suggests that children should be consulted in the development of school-based interventions so that appreciation of the intervention is better guaranteed, in order to optimize intervention effects.

Evaluation of school-based healthful nutrition promotion interventions should be based on accurate and valid assessments of intake levels and potential mediators of intakes \(^{24}\). Collecting accurate intake data based on observations or biomarkers is often possible in smaller scale, carefully controlled efficacy studies, but not in larger-scale studies in real-life settings. Collecting blood samples in children introduces bias because of low participation rates \(^{25,26}\). FFQ are therefore generally used. However, these questionnaires rely on participants’ memory and cognition, which may influence the accuracy of the reported intake; but this bias is believed to be the same in the control as in the intervention group. In the present study we used both child- en parent-reported intake levels for assessment of effects. The regression coefficients for fruit intake were approximately the same in both the child-reported data and the parent-reported data, which makes the evidence for intervention effect stronger. Also, the regression coefficients for vegetable intake were approximately the same for parents’ reports and children’s reports.
In another publication concerning the same study population, Tak et al. concluded that the level of agreement between child-reported F&V intakes and parent-reported F&V intakes was low at the baseline measurement. In the present study the reported intakes at second follow-up (2 years later) were much more alike, although the children still reported somewhat higher intake levels. This result further supports the earlier conclusion that child and parent reports tend to be more similar for somewhat older schoolchildren.

A disadvantage of the research design applied in the present study is that randomisation was not possible, since the Dutch government had indicated the intervention cities. Our analyses showed some baseline differences between intervention and control groups; the fact that schools were not randomly allocated may have introduced bias. Notably, the baseline difference for the parent-reported vegetable intake was significant. An explanation could be that there were relatively more children with a non-Western ethnicity in the intervention group compared with the control group. Tak et al. concluded elsewhere about this project that children with a non-Western ethnicity reported an higher vegetable consumption than the children with a Dutch ethnicity. Therefore, we adjusted all analyses for baseline differences to solve this problem. However, it may still have affected the results of the intervention since it was more difficult to further increase the vegetable intake among the children of the intervention group compared to the children from the control group.

Another bias may have occurred due to some selective dropout; however, loss to follow-up was not a consequence of an autonomous decision of the child, but was primarily caused by dropout of eight schools and in some cases based on parental decisions.

CONCLUSION

The present study provides some evidence that the Schoolgruiten intervention was effective in increasing children’s fruit intake and increasing the knowledge of recommended intake levels among boys at 2-year follow-up, and confirms results from earlier studies that indicated that school-based F&V schemes with additional school curriculum activities can have significant effects. Furthermore, children’s appreciation of the project appeared to mediate the intervention effects for fruit intake and future interventions should take this into account in order to achieve positive intervention effects.
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The effects of a fruit and vegetable promotion intervention on unhealthy snacks during mid-morning school breaks. Results of the Dutch Schoolgruiten Project

Re-submitted for publication as:
Tak NI, Te Velde SJ, Singh AS & Brug J The effects of a fruit and vegetable promotion intervention on unhealthy snacks during mid-morning school breaks. Results of the Dutch Schoolgruiten Project
ABSTRACT

Objective: The aim of the present study was to investigate if a school-based intervention that promoted the intake of fruit and vegetable (F&V) can at the same time reduce the intake of unhealthy snacks during school breaks.

Methods: Data was used from the Dutch Schoolgruiten Project; a F&V promotion intervention for primary schoolchildren. The study applied a longitudinal design with baseline and two follow-up measurements; second follow-up was conducted exactly two years after the baseline measurement. Children were 9-10 years-old at baseline; 705 children were included in this study. The amounts of F&V and unhealthy snacks for consumption during the mid-morning break at school were measured using a single item question included in a questionnaire, completed by the children during school hours. One parent per child completed an additional questionnaire with the same question. Multilevel autoregressive logistic regression models with a three level structure (school, child, and time) were used to assess the effect of the intervention on both F&V consumption and unhealthy snacks.

Results: According to the child reported data, the children of the intervention group brought significantly more often F&V from home to school at follow-up than the children of the control schools (OR=1.41, 95% CI= 1.04; 1.90). Results of the parent reported data supported this observation (OR=1.58, 95% CI=1.10; 2.28). Adjusting for the amount of unhealthy snacks brought from home did not influence the results. According to the child reported data, the children of the intervention schools brought fewer unhealthy snacks from home to be eaten in the mid-morning break at follow-up (OR = 0.56, 95% CI=0.34; 0.92).

Conclusion: The present study provided some evidence that the Schoolgruiten intervention effect on F&V intakes at same time reduced unhealthy snacking during school breaks.
INTRODUCTION

Epidemiological evidence for an association between eating enough fruit and vegetable (F&V) and a decreased risk for chronic metabolic diseases like obesity, hypertension and type 2 diabetes is regarded as convincing and high intakes of F&V are part of official recommendations for healthful eating in many countries. However, most children in Western countries, including the Netherlands, do not comply with F&V recommendations. Therefore, several interventions aimed at the promotion of F&V intake have been studied.

In line with efforts in other countries, several campaigns and interventions have been conducted in the Netherlands, including the Schoolgruiten Project (a Dutch acronym for ‘school fruits and vegetables’). This project was implemented in primary schools and the main aim was to improve accessibility of F&V at school by providing a serving of fruit or vegetable twice a week at no cost. The intervention showed mixed positive effects after one year follow-up and positive effects on fruit intake after two year follow-up.

The health enhancing effects of eating more F&V will be more apparent if the increased F&V consumption additionally leads to lower intakes of unhealthy snacks, such as high-calorie, sugar, fat, and/or salty snacks. Interventions that shift choice from high-calorie, sugar, fat, and/or salty snacks to healthier lower calorie snacks (i.e. F&V) may reduce caloric intake, thereby enhancing the efficacy of obesity prevention and treatment. However, little is known about whether interventions aimed at increasing F&V consumption result in lower intakes of unhealthy snacks. A study found that normal-weight participants had shifted choice from unhealthy snack foods to healthy foods and non-food alternatives when access to unhealthy snack foods was decreased, indicating that healthy food and non-food alternatives can substitute unhealthy snacks. Bere et al. found that during an intervention aimed at increasing F&V intake, some subgroups had shown significant reductions in soda/candy/chips consumption. Likewise, the Squire’s Quest! Intervention, an intervention aimed at increasing F&V consumption at schools, was effective in improving eating fruit and 100% fruit juice as snacks, and eating vegetables at lunch. Another study concluded that children ate more fruit at school when school policies did not allow adolescents to bring in unhealthy foods from outside.

Data of the Schoolgruiten Project provide the opportunity to study if the children ate fewer unhealthy snacks and more F&V during the mid-morning break at school as a result of the intervention and how the intake of F&V and unhealthy snacks are interrelated. We hypothesized that the children brought fewer unhealthy snacks and more F&V from home to school to be consumed during the mid-morning break.
METHODS

Description of the Schoolgruiten intervention
Since earlier studies and reviews indicate that taste preferences, availability and accessibility are important determinants of F&V consumption among children, and because F&V intakes should be promoted through changes in such presumed mediators, the main strategy within the Schoolgruiten Project targeted these factors. Therefore, the main strategy of the Schoolgruiten Project was a F&V scheme improving availability, accessibility and exposure of F&V at school. The children in the intervention group received a piece of fruit or ready-to-eat vegetables (cherry tomatoes, baby carrots) for free twice a week during a fruit break. The aim of the Schoolgruiten Project was that all children eat the piece of fruit or vegetable together in their own classroom, supervised by their own teacher. Apart from increasing availability and accessibility, this F&V scheme was also supposed to increase the children's exposure to F&V by eating F&V together. Repeated exposure is an important determinant of taste preferences.

Schools were not obliged to change their school policy regarding (unhealthy) snacks in the mid-morning break, but schools were asked to encourage the children and their parents to bring F&V from home to school on the days F&V were not provided. Within the Schoolgruiten Project we developed the ‘Schoolgruiten lunch box’, a lunch box with an additional space to put a piece of fruit or vegetable in. This box was meant to encourage the children to bring F&V from home to school. The project team developed also some kind of calendar on which the teacher could point out when the free F&V would be distributed and encouraged the children to bring F&V by their self on the remaining days. The parents received a newsletter with information about the project and those instruments. In this letter, the parents were encouraged as well to give F&V to their child on the days F&V were not provided. Unfortunately, we have no data to what extend the schools actually used those instruments.

Additionally, a school curriculum, developed and carefully pre-tested by the Netherlands Nutrition Center Foundation, aiming at increasing knowledge and skills related to F&V consumption was offered to the intervention schools. The intervention schools were not obliged to use this curriculum, but they were encouraged to do so.

Recruitment of the schools and study sample
The design of the Schoolgruiten evaluation study was quasi experimental, with a pre- and post-test, and an intervention and control group. Since the intervention cities were decided upon by the authorities (the Dutch ministry of Public Health, Welfare and Sport), random assignment to the control or intervention condition was not possible.
Primary schools of two of the intervention cities were selected to participate in the evaluation study. The Schoolgruiten research group selected three other comparable cities in the same region of these intervention cities in which primary schools were recruited to serve as control schools. There were baseline differences between the intervention and control groups, with regard to ethnicity and educational level of the parents. Therefore, all analyses were adjusted for age, gender, educational levels of the parents, ethnicity, and region of residence.

All fourth grades (9-10-year-olds) from primary schools in these five cities were eligible for participation at baseline and schools were approached by telephone, and invited to participate in this survey. Recruitment ended when 55 primary schools had agreed to participate in the survey, of which 31 were intervention schools and 24 were control schools, ensuring a sample of at least 600 children of the 4th grade in each group.

**Measurements**

The baseline measurement was conducted prior to the start of the intervention in 2003. First follow-up among the same children was exactly one year later and second follow-up was conducted exactly two years later. Both children as well as their parents completed questionnaires about the child’s intake and potential determinants, allowing us to conduct analysis based on child as well as parent reports.

**Procedure**

Children completed the questionnaire within one school hour guided by their own teacher in their classroom, based on a written administration protocol provided by the research staff. The children brought home a parent questionnaire to be completed preferably by the parent usually taking care of the child’s meals. Responses were treated anonymously and confidentially.

All fourth graders who were present on the day and hour of administration completed the questionnaires at baseline (n=1328). For the current study, we only included children that had valid data on all three measurements. This was a total of 346 children (148 parents) of the intervention group and 425 children (287 parents) of the control group. Study attrition was a result of children moving to another school or town, not graduating to the next grade or a decision of the school board to quit the study. More information about the recruitment and drop-out rates has been published previously.

The Project was approved by the Netherlands Organization for Health Research and Development (ZonMw), Program for Prevention. Informed consent was authorized by a legal representative (the school board).
Questionnaires
Separate questionnaires containing parallel questions assessing F&V intake and related variables for children and parents were developed, adapted from the Pro Children questionnaire. For the current study, we only used a single item measure to assess what was brought from home to school to be consumed during the mid-morning break at a regular school day. The answer alternatives (relevant for this study) were; fruit, vegetables, candies, chocolate bars, and potato crisps. The question was the same for children and their parents and they ticked off the relevant options. A similar question was also used in the Pro Children Study and showed significant relationships with fruit intake frequency and home availability of fruit, and with vegetable intake frequency and home availability of vegetables, indicating good construct validity. Likewise, the single item measure used for this study was also associated with home availability.

In addition, educational level of the parents (primary school or pre-vocational training=low; high school or medium level vocational training=medium; high level vocational training, college or university training=high) and ethnicity were assessed.

Statistical Analyses
All analyses were performed on both child and parent reported data. Means, standard deviations, and percentages were calculated to describe the key variables. The answers for the question that asked for what was brought from home to school to be consumed during the mid-morning break were used to create two new variables; one for the F&V that counted the number of F&V and another that counted the number of unhealthy snacks. Both variables were not normally distributed, and therefore dichotomized into no F&V (0) or snacks (0) and one or more F&V (1) or one or more snacks (1).

Associations between consumption of F&V and unhealthy snacks on the three measurement times were assessed using chi-square test.

To estimate the effect of the intervention on the number of F&V and unhealthy snacks brought from home to school to be consumed during the mid-morning break for the two follow-up measurements, multilevel autoregressive logistic regression models with a three level structure (school, child, and time) were used. The three level structure takes into account that effects may cluster within schools/classes and that repeated observations cluster within children. Autoregressive models were used to account for values measured at the previous observation. Therefore, the models included the outcome variable at time point t-1 as a covariate and therefore results reflect the change in the outcome variable.
The estimated odds ratios (ORs) reflect the likelihood of bringing F&V or unhealthy snacks from home to school for consumption in the morning break for the intervention group compared with the control group. Two models were run. First, analyses were conducted to assess the effect on both the number of F&V snacks and unhealthy snacks brought from home to school not adjusted for each other. Second, effect on the number of F&V snacks was adjusted for the number of unhealthy snack and visa versa. All models were adjusted for age, gender, time, educational levels of the parents, ethnicity, and region of residence.

Since some parents had missing data on educational level, the number included in the multilevel autoregressive logistic regression analyses was 705 for the child reported data and 428 for the parent reported data.

Effect modification by gender was assessed by including gender x group interaction term in the model. When these terms approached significance (p<0.10), analyses were stratified by gender.

Descriptive data analyses were performed using SPSS 14.0 (SPSS Inc., Chicago, IL, USA, 1999). The multilevel autoregressive logistic regression models were conducted using MLwiN software (Version 2.11). The significance level was set at p<0.05.

RESULTS

Characteristics of the participants

The study sample consisted of slightly more girls than boys, in the intervention as well as in the control group (see TABLE 7.1). The majority of the children of the intervention group were of non-Dutch ethnicity, while in the control group the majority of the children had a native Dutch ethnicity. The age of all children ranged between 8.5-11.8 years at baseline.
TABLE 7.1: Characteristics of the children of the Schoolgruiten intervention study at baseline

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Intervention group</th>
<th>Control group</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean (SD) or %</td>
<td>N</td>
</tr>
<tr>
<td>Age of the children, years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>346</td>
<td>10.1 (0.6)</td>
<td>4245</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>148</td>
<td>42.8</td>
<td>198</td>
</tr>
<tr>
<td>Girls</td>
<td>198</td>
<td>57.2</td>
<td>226</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native Dutch children</td>
<td>135</td>
<td>39.0</td>
<td>301</td>
</tr>
<tr>
<td>Children of Western ethnicity</td>
<td>18</td>
<td>5.2</td>
<td>16</td>
</tr>
<tr>
<td>Children of non-Western ethnicity</td>
<td>193</td>
<td>55.8</td>
<td>107</td>
</tr>
<tr>
<td>Educational level of the parents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>110</td>
<td>36.3</td>
<td>69</td>
</tr>
<tr>
<td>Moderate</td>
<td>108</td>
<td>35.6</td>
<td>153</td>
</tr>
<tr>
<td>High</td>
<td>85</td>
<td>28.1</td>
<td>180</td>
</tr>
</tbody>
</table>

* as estimated by chi-square test (independent categorical data)

**Pieces of F&V and unhealthy snacks**

Most of the children brought no fruit or vegetables nor unhealthy snacks from home to school to be consumed during the mid-morning (see TABLE 7.2). The percentage of children in the intervention group that brought fruit or vegetables from home to school was somewhat higher than the percentage in the control group, for all three measurements.

Based on the child-reported data, no significant associations were observed between the number of F&V and the number of unhealthy snacks brought from home to school for the three measurement times (baseline $X^2=0.084$; $P=0.772$, first follow-up $X^2=0.028$; $P=0.867$, second follow-up $X^2=1.333$; $P=0.248$).

According to the child reported data, the children of the intervention group brought significantly more often F&V from home to school at follow-up than the children of the control schools (OR=1.41, 95% CI=1.04–1.90) (TABLE 7.3). Results of the parent reported data supported this observation (OR=1.58, 95% CI=1.10–2.28). Adjusting for the amount of unhealthy snacks brought from home did not influence the results. According to the child reported data, the children of the intervention schools brought fewer unhealthy snacks from home to be eaten in the mid-morning break at follow-up (OR = 0.56, 95% CI 0.34 –0.92), which was also not effected by adjustment for the number of F&V snacks brought from home.
**TABLE 7.2:** Number and percentages of children who reported to bring (Yes) and not to bring (No) F&V and snacks from home to be consumed during the mid-morning break at school in the intervention and control group at baseline, at first and at second follow-up

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Follow-up 1</th>
<th>Follow-up 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>Yes</td>
<td>Total</td>
</tr>
<tr>
<td><strong>FRUIT &amp; VEGETABLES</strong></td>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Intervention group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>177</td>
<td>51</td>
<td>114</td>
<td>33</td>
</tr>
<tr>
<td>Yes</td>
<td>29</td>
<td>8</td>
<td>26</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>206</td>
<td>59</td>
<td>140</td>
<td>41</td>
</tr>
<tr>
<td>Control group</td>
<td>N = 424</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>245</td>
<td>58</td>
<td>104</td>
<td>24</td>
</tr>
<tr>
<td>Yes</td>
<td>55</td>
<td>13</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>300</td>
<td>71</td>
<td>124</td>
<td>29</td>
</tr>
</tbody>
</table>
Chapter 7

TABLE 7.3: Odds ratios (OR) and 95% confidence intervals (95% CI) for the effect of the intervention on the amount of F&V and unhealthy snacks brought from home to be consumed during the mid-morning break at school

<table>
<thead>
<tr>
<th></th>
<th>F&amp;V brought from home to be consumed during the mid-morning break</th>
<th>Unhealthy snacks brought from home to be consumed during the mid-morning break</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR #</td>
<td>95% CI</td>
</tr>
<tr>
<td>Child-reports, model 1*</td>
<td>1.41</td>
<td>1.04 – 1.90</td>
</tr>
<tr>
<td>Child-reports, model 2**</td>
<td>1.43</td>
<td>1.06 – 1.94</td>
</tr>
<tr>
<td>Parent-reports, model 1*</td>
<td>1.58</td>
<td>1.10 – 2.28</td>
</tr>
<tr>
<td>Parent-reports, model 2**</td>
<td>1.59</td>
<td>1.10 – 2.29</td>
</tr>
</tbody>
</table>

All multilevel (three level structure; school, child, and time) autoregressive logistic regression analyses are adjusted for children's age, gender, ethnicity, education level of the parents, region of residence and outcome at t-1

# OR – odds ratio for comparison with the control group.

* Model 1 – analyses with F&V not adjusted for unhealthy snacks, and vice versa

** Model 2 – analyses with F&V adjusted for unhealthy snacks, and vice versa

DISCUSSION

The present study aimed to assess whether an intervention that made F&V ready available in the classroom could at the same time decrease the number of unhealthy snacks brought from home to school to be consumed during the mid-morning break. Results indicated that children in the intervention group more often brought F&V and less often brought unhealthy snacks from home to school. Based on the parents' reports, we only found significant positive effects on the number of F&V brought from home, and no effect on the number of unhealthy snacks brought from home to school. The reason that we did not find significant results in the parents' reports on unhealthy snacks may be partly due to power issues; since parent-report data were available for fewer children (the ORs are in the same direction as the child data). The parents could only report what they gave their child school, so the consumption of the free F&V provided at school was not included in this measure. The same applied for the children; they answered the question about what they brought to school, and the free F&V was not taken into account for this question.

It is reasonable to assume that children consumed what they brought from home, because in the Netherlands, primary schools do not have canteens or vending machines to buy any food or drinks. In addition, most children of primary schools are brought
to school by a parent and children are not allowed to leave the school or schoolyard
during school hours. It might be that the Schoolgruiten intervention directly affected
the parents and made them give fewer unhealthy snacks and more often fruit or
vegetables to their child to bring to school to be eaten in the mid-morning break.
Our data show that according to the child-reported data, an intervention aimed at
increasing F&V consumption can at the same time decrease the number of unhealthy
snacks brought from home. It is often assumed that increasing F&V intake would almost
automatically result in a decrease in intake of other foods, such as unhealthy snacks.
Very few studies, however, have actually assessed whether this is the case, and lack of
compensation could lead to higher calorie intake and contribute to further unnecessary
weight gain. In the current study we found no significant associations between the
number of F&V and the number of unhealthy snacks and results from the multilevel
autoregressive logistic regression analyses did not show that effects on the number of
snacks brought from home could be explained by the number of F&V and vise versa.
This might indicate that F&V consumption and unhealthy snack consumption are not
strongly associated, but increasing the one (F&V) was mildly associated with a decrease
of the other (snacks).
One of the few studies that investigated if F&V can substitute snack foods among
children is the study of Goldfield and Epstein 7. They concluded that normal-weight
children shifted their choice from unhealthy snacks to both healthy snacks and non-
food alternatives when the access to snack foods had been decreased by increasing the
costs of these foods. This indicates that healthy snacks and non-food alternatives can
substitute unhealthy snacks 7.
Bere et al. have evaluated a F&V intervention among primary schoolchildren in Norway
in which unhealthy snacks were measured 8. This Norwegian study found that the pupils
who were either in the free or in the paid subscription program significantly reduced
their snack and softdrink consumption compared to children not receiving free or paid
fruit 8. In line with the current study, this demonstrates that effective F&V interventions
can have an additional effect on the consumption of unhealthy foods and beverages.
The behavior choice theory 7 may help to explain the results of this study. This theory is
designed to understand how people allocate choices among alternatives. Replacement
is an important concept in this theory. People may choose an alternative for a preferred
product, when availability of this product is constrained. In this intervention, it may
have been that access to snacks was constrained, because parents were influenced by
the subscription program and gave fewer unhealthy snacks to be consumed during the
mid-morning break at school. A solution to restrict access to unhealthy snacks may be
by means of school policies. Moore and Tapper 10 suggested that when children are not
allowed to bring unhealthy snacks to school, their willingness to eat fruit as a snack at school is greatly enhanced 10.

Some limitations of the present study need to be addressed. First, all measurements were based on self-reported data, which may have resulted in socially desirable answers. The outcome variable was measured using a single item, but findings in the child data were supported by the findings in the parent data, indicating an acceptable validity of this question. Further, a disadvantage of the research design applied in the Schoolgruiten intervention is that randomization was not possible, since the Dutch government had indicated the intervention cities. Although our analyses indicated some baseline differences between the intervention and control groups, the fact that schools were not randomly allocated may have introduced bias.

Despite the fact that the intervention was not primarily developed to decrease the amount of unhealthy snacks, the present study provides some evidence that the Schoolgruiten intervention was effective in increasing F&V consumption and decreasing unhealthy snacks brought from home to school for consumption during the mid-morning break. It further indicates that restricted access to unhealthy snacks may play an important role to reduce snack intake during school breaks.

CONCLUSION

The present study provided some evidence that the Schoolgruiten intervention effect on F&V intakes at same time reduced unhealthy snacking during school breaks.

REFERENCE LIST


(4) World Health Organisation. Promoting fruit and vegetable consumption around the world.


Chapter 7

Long term health outcomes and cost-effectiveness of two school-based interventions promoting fruit and vegetable intakes among 11-year-old Dutch children

Submitted for publication as:
Te Velde SJ, Veerman L, Tak NI, Bosmans JE & Brug J Long term health outcomes and cost-effectiveness of two school-based interventions promoting fruit and vegetable intake among 11-year-old Dutch children
ABSTRACT

Objectives: Assessing the cost-effectiveness of a nation wide implementation of two school-based interventions promoting fruit and vegetable (F&V) intake among primary schoolchildren in the Netherlands compared to ‘no intervention’.

Methods: Effects of the intervention in terms of F&V intake were assessed and epidemiological modelling was used to estimate the number of health-adjusted life years gained over the lifetime of all the children aged 11 years in the Netherlands. Incremental Cost Effectiveness Ratios (ICER) and Net Monetary Benefits (NMB) were estimated and one-way and probabilistic sensitivity analyses were conducted.

Findings: If the intervention effects can be sustained for 30%, the Pro Children intervention was estimated to result in a gain of 326 DALYs/100,000 children and the Schoolgruiten intervention in a gain of 196 DALYs/100,000 children. The Pro Children intervention was also more cost-effective than the Schoolgruiten intervention in terms of the estimated ICER (€7,912/DALY vs. €13,906/DALY) and NMB (€4,230,379 vs. €272,877). Using the Dutch per capita income as a decision threshold (€19,600) the probability that the Pro Children intervention was cost-effective was 76% and that the Schoolgruiten intervention was cost-effective was 60%.

Conclusion: Epidemiological modelling and economic evaluations including extensive sensitivity analyses estimated that both the Pro Children intervention and the Schoolgruiten intervention were cost-effective.
INTRODUCTION

School-based interventions can be effective in increasing children’s fruit and vegetable (F&V) intake. This is important since large proportions of schoolchildren consume less F&V than recommended. Two examples of successful school-based interventions implemented in the Netherlands are the Pro Children intervention and the Schoolgruiten intervention. Both interventions were multi-component interventions including a free F&V scheme, a school curriculum and the involvement of parents. For further implementation of such interventions, it is important to assess if the benefits outweigh the costs. For most public health interventions and health behaviour change interventions in particular, such cost-effectiveness assessments come with specific challenges, since the health benefits in terms of lower disease risk, more healthy life years and possibly lower health care costs will occur only at the longer term, often long after the final measurement for intervention evaluation have been completed. Therefore, health behaviour change interventions are mostly evaluated based on intermediary effects, such as changes in behaviour and future health effects have to be estimated. To date, this has not been done for existing school-based F&V interventions. The current study aimed at estimating future health effects and at the same time to combine these estimates with an economic evaluation. To estimate the future health effects, a model based on the proportional multi-state life table was used to first calculate the prevalence of ischemic heart disease and certain cancers, and mortality and then translate this to life expectancies, years lost to disease and health-adjusted life-years (DALYs). Additionally, for the present study an economic evaluation comparing the two Dutch interventions to ‘no intervention or doing nothing’ was performed. The future effects of the interventions, in terms of health gain in DALYs averted if the intervention was to be implemented among the school-aged population at large, were estimated using the epidemiological modelling approach as described above. Subsequently the lifetime health gain was compared to the lifetime costs in both cost-utility and cost-benefit analyses. Finally, univariate and probabilistic sensitivity analyses were conducted to test the robustness of the findings.
METHODS

The Pro Children and Schoolgruiten interventions
Detailed descriptions of both interventions have been published previously 1-3,7,8. Briefly, the Pro Children intervention consisted of three main components. The school component consisted of the provision of a piece of fruit, a carrot or a tomato for free twice a week; the classroom curriculum consisted of worksheets and a web-based computer tailored feedback tool 9 and the family component encouraged parents to be involved in the project by means of their children’s homework assignments, parental newsletters and a parent version of the web-based computer tailored tool. The distribution of F&V continued for two years, while the curriculum and parent activities were less extensive in the second year compared to the first year.

The Schoolgruiten intervention was comparable to the Pro Children intervention in that the main strategy was to improve availability and accessibility of F&V at school through a F&V scheme. Additionally, the schools were encouraged, but not obliged, to use a curriculum to increase knowledge and skills related to F&V consumption. The Schoolgruiten intervention lasted for two school years and did not include a family component nor a computer tailored feedback tool.

Epidemiological modelling
Future health effects induced by an increased F&V intake were estimated by means of epidemiological modelling. Most of these health effects occur only after many years when cardiovascular disease and cancer become more prevalent, which precludes measurement. Epidemiological modelling of these health outcomes is the only realistic alternative 10.

The modelling procedure comprised two steps: the estimation of the effect of the intervention on F&V consumption, and subsequently the translation of these consumption effects into changes in health outcomes.

Step 1 Estimates of the intervention effect
For both interventions used in the present study, formal impact evaluations in terms of behaviour change, i.e. changes in F&V intakes were performed and have been published 1,2. For the current study data was reanalysed to provide effect estimates for the whole sample for F&V intake combined. The Pro Children intervention resulted in an estimated intervention effect of 78.8 (95%CI 27.1; 130.5) gram/day after one year of implementation of the full intervention. Two years into the intervention, with a less intensive second year, the effects diminished and effects were no longer significant
in the Netherlands (28.7 (95%CI -12.8 - 70.1) gram/day, 10.1% difference between intervention and control group). For the Schoolgruiten intervention the effect one year into the intervention was 29.6 (95%CI 14.3-45.0) gram/day. Also in the Schoolgruiten intervention the effects diminished and effects were not statistically significant anymore after two years (17.4 (95%CI -0.89-35.58) gram/day, 6.2 % difference between intervention and control group) 2,3. Effects at two years were used as input for our model. Although the intervention effects of both interventions were not statistically significant after two years, these effect estimates are better than assuming there is no effect at all.

**Step 2 epidemiological model**

A model based on the proportional multi-state life table was used to estimate the health outcomes 10,11. In brief, the model compares a reference population that is modelled after the Dutch population to an identical ‘intervention population’ in which the consumption of F&V can be manipulated. The consumption of the intervention population was changed according to the intervention effects of the Pro Children and Schoolgruiten interventions. The consumption data for the Dutch reference population were derived from the most recent National Food Consumption Survey 2003, which covered ages 19 to 30 years 12. The mean intake levels (gram/day) were fitted to a Gamma distribution of which the mean was shifted upwards in the intervention population. This resulted in a new distribution pattern, which was translated into different consumption categories (< 80; 80-160; 160-240; 240-320; 320-400 and > 400 gram/day). The new consumption levels around age 12 were extrapolated to those over the rest of the lifetime by applying the same proportional increase. However, little is known about the tracking of F&V consumption levels. A recent study suggested moderate tracking from adolescence into adulthood 13, but no data has been published on tracking from young adulthood into late adulthood. Therefore, the latest survey data on consumption at ages 19 to 30 was used under the assumption that the change in consumption at age 12 translates to an equal percentage change at higher ages, and that this consumption pattern is maintained throughout life. It is, however, likely that not 100% of the intervention effects last lifelong. Therefore, an arbitrary value of 30% was applied in the current study and varied in the sensitivity analysis.

Higher F&V intake levels are associated with a lower incidence of ischemic heart disease, ischemic stroke and cancer of the oesophagus, stomach, colorectum and lung 14. This effect was quantified via the potential impact fraction (PIF), which is defined as the proportional change in expected incidence as a consequence of a specified change in exposure level 15. PIF is calculated on the basis of age- and gender-specific exposure data and the relative risks of disease incidence at the corresponding levels of exposure.
Age-specific relative risk estimates were obtained from the WHO Comparative Risk Assessment exercise 14. From the PIFs and the incidence in the reference population the model calculates the incidence in the intervention population. The incidence rates in the reference population are based on incidence- and mortality estimates over the year 2000 from the Netherlands National Institute for Public Health and the Environment, which in turn based them on GP-registries (for incidence data), and data from Statistics Netherlands (mortality data). Consistency between the different epidemiological data was enforced with the DisMod II tool 16. Incidence and mortality rates from causes other than the diseases included in the model were assumed stable. From the new age-specific incidence rates, the model now calculates the new prevalence and mortality in the intervention population separately for men and women. This data is integrated in a life table to calculate life expectancy, years lost to disease and health-adjusted life-years (DALYs). The Dutch disability weights were used to estimate the health-related quality of life lost due to the diseases in the model 17. The difference in health outcomes between the reference population and the intervention population is attributed to the intervention (DALYs saved will be expressed as number per 100,000 children).

**Costs**

Costs made for the development and implementation of the Pro Children Study were reported in special forms and divided in two categories: 1) curriculum and materials and 2) the F&V scheme. Costs for the development and implementation of the Schoolgruiten Project were retrieved from AGF-promotion, the organisation responsible for the implementation of the project. The average implementation costs per participating child in the 2-year intervention were calculated. To estimate the costs for a nation wide implementation among all 10-year-olds in the Netherlands, the costs per participating child were multiplied by the total number of 10-year-olds in the Netherlands as obtained from Statistics Netherlands.

The costs of the intervention and age-specific health care costs 18 in the Netherlands in 2006 were incorporated in the epidemiological model. For the calculation of ‘net benefit’ in the base case, a DALY was conservatively valued as one per capita income 19, which is about 19,600 Euro for the Netherlands. A discount rate of 3% per annum was applied to both costs and health outcomes.
Cost-effectiveness of school-based interventions promoting F&V intake

Economic evaluation

The Incremental Cost-Effectiveness Ratio (ICER) was calculated as:

\[
\text{ICER} = \frac{\text{Net intervention costs} + \text{difference in health care costs}}{\text{DALYs saved by intervention}}
\]

The ICER was used to estimate cost-utility of the intervention. In addition, the ICER was calculated without the inclusion of the lifetime health care costs.

Next, the ‘net monetary benefit’ (NMB) of both interventions was calculated, which we defined as the value of the DALYs gained plus health care costs averted, minus the cost of the intervention. Again, the NMB without taking health care costs averted into account was calculated. The ICERs assume a health services perspective (defining the interventions as a form of preventive health care). The NMB estimates assume a societal perspective, which is consistent with how the value of one DALY has been estimated by the WHO.\(^{19}\)

Sensitivity analysis

Sensitivity analyses were conducted to test the robustness of the estimates to changes in critical assumptions. In one-way sensitivity analyses, the proportion of the intervention effect that lasts lifelong, the costs, the discounting rates for both costs and health effects and for health effects alone, and finally the value of one DALY were varied. TABLE 8.1 provides an overview of the input in the sensitivity analyses.

In a ‘probabilistic sensitivity analysis’ (or ‘uncertainty analysis’) a bootstrap was performed (10,000 iterations) to estimate the uncertainty around the point estimates.\(^{20}\) The Ersatz programme (Barendregt, Brisbane 2007) was used to vary simultaneously the key epidemiological, effectiveness, and cost parameters. TABLE 8.2 presents the parameters, values, and sources for the estimates. Results from the bootstrap were also used to create a cost-effectiveness acceptability curve (CEAC). The CEAC is a graphical method of summarizing information on uncertainty in cost-effectiveness estimates. The CEAC indicates the probability that an intervention is cost-effective compared with the alternative for a range of maximum monetary values that a decision maker might be willing to pay for a particular unit change in the outcome.\(^{22,23}\)
TABLE 8.1: Parameter values for sensitivity analysis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean value/ basic case</th>
<th>Values in sensitivity analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention effect that lasts lifelong</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pro Children</td>
<td>30%</td>
<td>10, 30, 50 and 100%</td>
</tr>
<tr>
<td>Schoolgruiten</td>
<td>30%</td>
<td>10, 30, 50 and 100%</td>
</tr>
<tr>
<td>Intervention costs per child (Euros)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pro Children</td>
<td>€ 42.04</td>
<td>€ 20.-, € 42.04 and € 60.-</td>
</tr>
<tr>
<td>Schoolgruiten</td>
<td>€ 36.92</td>
<td>€ 20.-, € 36.92 and € 60.-</td>
</tr>
<tr>
<td>Discounting rates</td>
<td>3%</td>
<td>0%, 3% and 5%</td>
</tr>
<tr>
<td>Both costs and health effects</td>
<td>3%</td>
<td>0%, 3% and 5%</td>
</tr>
<tr>
<td>Health effects alone</td>
<td>3%</td>
<td>0%, 3% and 5%</td>
</tr>
<tr>
<td>Value of a DALY</td>
<td>€ 19,600</td>
<td>€ 19,600, € 39,200 and € 58,800</td>
</tr>
</tbody>
</table>

TABLE 8.2: Input probabilistic sensitivity analysis

<table>
<thead>
<tr>
<th>Values (95% CI)</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect Pro Children</td>
<td>10.1% (-4.5%, 24.4%)</td>
</tr>
<tr>
<td>Effect Schoolgruiten</td>
<td>6.1% (-0.3%, 12.4%)</td>
</tr>
<tr>
<td>Costs Pro Children</td>
<td>42.04 (34.46, 50.50; SD +/- 10%)</td>
</tr>
<tr>
<td>Costs Schoolgruiten</td>
<td>36.92 (31.21, 44.76; SD +/- 10%)</td>
</tr>
<tr>
<td>Relative risks of diseases 28</td>
<td>Varies by age</td>
</tr>
</tbody>
</table>

RESULTS

Shift in consumption levels

As mentioned before, in both the Pro Children (10.1%) and the Schoolgruiten intervention (6.1%) the intervention group reported a difference F&V intake after two years compared to the control group. FIGURE 8.1 shows the estimated shift in F&V consumption in the modelled Dutch intervention population.

Health effects

Future intervention effects of the Pro Children intervention as modelled by the multi-state life table were estimated at a gain of 326 DALYs / 100,000 children (403 DALYs/ 100,000 boys, 245 DALYs/ 100,000 girls) for over the lifetime of the cohort of all children aged 12 in 2003 in the Netherlands (discounted). The future intervention effects for the Schoolgruiten intervention were estimated to be a bit less: 196 DALYs / 100,000 children for over the lifetime of the cohort (242 DALYs/ 100,000 boys and 147 DALYs/ 100,000 girls) of all 12-year-olds in the Netherlands.
FIGURE 8.1: Expected consumption levels of fruit and vegetables among the cohort of Dutch men aged 12 in 2003 without intervention (white), with the Pro Children intervention (black) and with the Schoolgruiten intervention (shaded) under the assumption that 30% of the effect measured at 2 years persists lifelong. A higher proportion of the men falls in the higher consumption categories, but still less than 10% adheres to the WHO recommendation of at least 400 grams per day.

Costs
The estimated costs for the implementation of the 2-year Pro Children intervention in the Netherlands was € 42.47 per student. Costs of implementing the 2-year Schoolgruiten intervention were € 37.47 per student. Translating these costs to a nationwide implementation among all 10-year-olds the costs will come to € 16.2 million for the Pro Children intervention and to € 14.3 million for the Schoolgruiten intervention. In the base case, as a result of the Pro Children intervention, the society could expect to save an estimated € 3.1 million in health care costs. The savings for the Schoolgruiten intervention was estimated to be € 1.8 million. Therefore, the ICER is € 7,912/DALY for the Pro Children intervention and € 13,906/DALY for the Schoolgruiten intervention. When not considering health care costs saved, the ICERS were estimated to be € 12,884/DALY and € 18,877/DALY for the Pro Children and Schoolgruiten intervention respectively (see TABLE 8.3).

The NMB for the Pro Children intervention was estimated to be € 7.3 million and for the Schoolgruiten intervention to be € 2.2 million. When health care costs averted were assumed to be included in value attributed to the DALY, the estimated NMBs were € 4.2 million and € 0.3 million for the Pro Children and Schoolgruiten intervention respectively.
TABLE 8.3: Results in terms of cost-effectiveness for both the Pro Children intervention and the Schoolgruiten intervention

<table>
<thead>
<tr>
<th></th>
<th>Pro Children</th>
<th>Schoolgruiten</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICER, including Health Care costs</td>
<td>7,912</td>
<td>13,906</td>
</tr>
<tr>
<td>ICER, not including Health Care costs</td>
<td>12,884</td>
<td>18,877</td>
</tr>
<tr>
<td>NMB, including Health Care costs</td>
<td>€ 7,362,020</td>
<td>€ 2,150,014</td>
</tr>
<tr>
<td>NMB, not including Health Care costs</td>
<td>€ 4,230,379</td>
<td>€ 272,877</td>
</tr>
</tbody>
</table>

ICER - Incremental Cost-Effectiveness Ratio; NMB – Net Monetary Benefit

Sensitivity analyses

In the one-way sensitivity analyses the estimated ICERs for the Pro Children intervention varied between cost-saving and € 33,533 and the NMBs varied between € -2.9 million and € 84.0 million (see TABLE 8.4). The most favourable estimates were derived from the calculation with no discounting, while the most unfavourable estimates came from the calculation in which the sustainability of the intervention was set at only 10% (ICER = € 33,502/DALY and NMB = € -2.9 million) or in which the discount rate was 5% (ICER = € 33,533/DALY and NMB = € - 2.9 million).

The probabilistic sensitivity analyses showed that for the Pro Children intervention was estimated to be cost saving with an upper limit of the ICER’s 95% uncertainty interval of 109,587 (see TABLE 8.4). The estimate for the NMB was € 7.2 million with a 95% uncertainty interval from € - 8.1 million to € 28.7 million. For the Schoolgruiten intervention the ICER was estimated to be € 26,388 with a 95% uncertainty interval from cost saving to 162,652. The NMB was estimated at € 2.0 million (95% uncertainty interval: € - 7.4 million – 15.0 million).
TABLE 8.4: Results of the one-way sensitivity and the probabilistic sensitivity analysis for both the Pro Children and Schoolgruiten intervention

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Incremental Cost-effectiveness ratio (ICER) 2</th>
<th>Net Monetary benefit (NMB) 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case 1</td>
<td>Pro Children: 7,912</td>
<td>Schoolgruiten: 13,906</td>
</tr>
<tr>
<td>One-way sensitivity analyses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention effect lasting life long</td>
<td>Cost-saving: 746</td>
<td></td>
</tr>
<tr>
<td>100%</td>
<td>2,794</td>
<td>6,386</td>
</tr>
<tr>
<td>50%</td>
<td>33,502</td>
<td>51,507</td>
</tr>
<tr>
<td>Intervention costs per child (Euros)</td>
<td>€ 20: 1,158</td>
<td></td>
</tr>
<tr>
<td></td>
<td>€ 60: 13,418</td>
<td>25,704</td>
</tr>
<tr>
<td>Discounting rates for both costs and health effects</td>
<td>Cost-saving: 33,533</td>
<td>Cost-saving: 51,519</td>
</tr>
<tr>
<td>0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>€39,200</td>
<td>7,912</td>
</tr>
<tr>
<td>Value of a DALY 2</td>
<td>€58,800</td>
<td>7,912</td>
</tr>
<tr>
<td>Probabilistic sensitivity analyses</td>
<td>Median: 8,381</td>
<td>14,624</td>
</tr>
<tr>
<td>Mean</td>
<td>Cost-saving: 26,388</td>
<td>Cost saving: -8,130,061</td>
</tr>
<tr>
<td>95% UI 3</td>
<td>-109,587</td>
<td>-162,652</td>
</tr>
</tbody>
</table>

1 In the base case, intervention effect lasting life long was set at 30%, intervention costs per child were € 42.04 for Pro Children and € 36.92 for the Schoolgruiten intervention, both discounting rates were 3% and the value of a DALY was € 19,600

2 In both the ICER and NMB the Health Care costs averted were taken into account

3 UI – Uncertainty Interval

The uncertainty about the cost-effectiveness of both interventions is further demonstrated in the cost-effectiveness plane shown in FIGURE 8.2. The location of the cost-effect pairs indicates the interventions are likely to increase net health sector expenses but positively contribute to health, because most points fall in the Eastern quadrants (> 97% for both interventions). However, the spread of the points in both the vertical and horizontal plane indicate that there is quite some uncertainty regarding the magnitude of the effect and the costs. All cost-effect pairs to the lower right of the diagonal line (decision threshold of € 19.600) were deemed cost effective.
As can been seen in FIGURE 8.3, for all decision thresholds, the Pro Children intervention has a higher probability of being cost-effective compared to no intervention than the Schoolgruiten intervention. For the decision threshold of € 19,600 the probability that the Pro Children intervention is cost-effective compared to no intervention is 76% and that the Schoolgruiten intervention is cost-effectives compared to no intervention is 60%.
FIGURE 8.3: Cost-effectiveness acceptability curves for the Pro Children (solid line) and the Schoolgruiten (intermittent line) intervention

DISCUSSION

The present study showed that the estimated future health effects for the Pro Children intervention if implemented nation-wide was estimated to be a gain of 326 DALYs / 100,000 children for all children in the Netherlands aged 12 in 2003 (assuming that 30% of the intervention effect lasts life long). For the Schoolgruiten intervention this was estimated to be 196 DALYs / 100,000 children. The economic evaluation showed a NMB of € 7.4 million for the Pro Children intervention and € 2.2 million for the Schoolgruiten intervention and ICERs of € 7,912 and € 13,906 for the Pro Children intervention and Schoolgruiten intervention respectively. Sensitivity analyses showed, however, that these estimates were strongly affected by assumptions regarding the proportion of intervention effects lasting life long and the discounting rate. Uncertainty around these estimates was substantial, as shown by the 95% uncertainty intervals around the point estimates for the ICERs and NMBs and the wide spread of the points in the cost-effectiveness plane.

Although the study had some clear limitations that will be discussed later, the current analyses provide the best cost-effectiveness estimate currently possible. Because of a lack of cost-effectiveness studies in the field of promotion of F&V intake, it is not known how the Pro Children and Schoolgruiten interventions compare with other
school-based programs promoting F&V intake. In the field of overweight prevention, the cost-effectiveness of two school-based interventions have been reported. The study of Wang et al. evaluated the Planet Health school-based obesity prevention program and estimated the ICER to be $4305/QALY (1996$). However, Dalziel and Segal argued that assumptions made by Wang et al. with regard to the observed gain in obesity prevalence that are retained beyond trial end were too optimistic. Dalziel and Segal recalculated the costs/QALY while adopting more conservative assumptions, which lead to estimates ranging from $69/QALY to $35,860/QALY. In the current study, a conservative arbitrary proportion of 30% of the intervention effects that would last life long was used in the modelling procedures. Another intervention that was considered cost-effective is the CATCH obesity prevention program. For this study, the ICER was estimated to be $900/QALY (2004$), which approximately equals € 669/QALY (2006€), but again, potential relapse after the program ended was not accounted for.

Limitations of the present study include that the modelling relied on intervention in terms of changes in self-reported consumption levels and the long term health effects had to be derived from epidemiological modelling. The probabilistic sensitivity analysis can account for some of these concerns but does not include the most important factor: how much of the effect is retained over the lifetime of the children. The one-way sensitivity analyses showed that the model calculating the cost-effectiveness was quite sensitive to changes in the main parameters. Estimates ranged from cost-saving to € 33,533/DALY for the Pro Children intervention and from cost-saving to € 51,519/DALY for the Schoolgruiten intervention. Likewise, both the cost-effectiveness plane (0) and the CEACs (0) showed considerable uncertainty around the point estimates.

Although both interventions were quite similar, the Pro Children intervention seemed more cost-effective than the Schoolgruiten intervention. The Pro Children was more expensive but also more effective. Both interventions included a F&V scheme and a school curriculum. In the Pro Children intervention, however, the curriculum had a more compulsory character while in the Schoolgruiten intervention teachers were only encouraged to use the curriculum materials. The Pro Children intervention additionally included a family component to engage parents, and computer tailoring. These distinctions do explain cost differences and may also account for the differences in effect and suggest that it was worth the extra investment.

Strengths of the current study were the modelling of long term effects, the extensive sensitivity analyses, including bootstrap analyses in which several parameters were varied at the same time, and a lifetime perspective (as opposed to e.g. Wang et al. ⁵⁴). Variation of uncertain parameters one at a time carries a risk that interactions between parameters may not be captured ⁵⁵.
CONCLUSION

Epidemiological modelling and economic evaluations including extensive sensitivity and uncertainty analyses estimated that the Pro Children intervention and the Schoolgruiten intervention were cost-effective. Using a decision threshold of € 19,600,- the probability that the Pro Children intervention is cost-effective is 76% and that the Schoolgruiten intervention is cost-effective is 60%.

REFERENCE LIST


**APPENDIX**

**TABLE 8.5:** Price index figures

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
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<td>100</td>
<td>104.2</td>
<td>107.6</td>
<td>109.9</td>
<td>111.2</td>
<td>113.1</td>
<td>114.4</td>
</tr>
</tbody>
</table>

Statline.cbs.nl
General discussion and conclusions
INTRODUCTION

This thesis reports on several studies examining different aspects of the Dutch Schoolgruiten Project, an intervention aimed at increasing F&V consumption among primary schoolchildren in the Netherlands. The objective of this thesis was threefold. First, to obtain insight into important and changeable correlates and predictors of children’s F&V intake by means of two different studies. Second, a study to assess the agreement between parent and child reports of the children’s F&V intake levels and family-related factors, as reported in the questionnaire we used. Third, to evaluate the Schoolgruiten intervention, for which both short- and long-term effects were described, as well as a cost-effectiveness evaluation. The purpose of this final chapter is to relate the main findings of the various studies to each other and to discuss several potential explanations of the findings. Methodological issues, as well as implications for future research and practice, will be addressed. These topics will be described and discussed separately for the three parts of this thesis.

SUMMARY OF MAIN FINDINGS

Part I Determinants of schoolchildren’s fruit and vegetables intakes

In the first part of the present thesis, two different studies that provided insight into important and changeable potential determinants of children’s F&V intake are presented. Results from the two studies revealed that taste preferences and liking of F&V, a positive attitude towards F&V, knowledge of recommended daily intakes of F&V, positive self-efficacy for F&V, positive role modelling for F&V, family rules for eating F&V, parental facilitation of F&V, and availability at home of vegetables were important potential personal determinants of intake. These personal factors seemed to be of greater importance for fruit intake than for vegetable intake.

Results of one of the investigated associations in chapter three indicated that behaviour change (increase in F&V intake frequency) was preceded by changes in the following determinants: liking of fruit, parental facilitation of vegetables, family rules for eating vegetables, and availability of vegetables at home. Additional analyses showed that changes in F&V intake frequency preceded changes in knowledge of recommended intake levels of fruit intake and liking of F&V later in time.
Part II  Measurement issues of intake
The second part of this thesis is rather small, with just one chapter, but it deserves separate treatment as it explores an important methodological issue. The aim of this study was to investigate the level of agreement between parent and child reports of the children's intake levels and some related potential family environmental determinants. The results in chapter four showed that agreement between parent and child reports of F&V intakes and potential family determinants of F&V intakes was weak to moderate. Children from the fourth grade reported significantly higher F&V intakes than did their parents. One year later, at first follow-up, the differences were smaller than at baseline, but still statistically significant. Weighed Cohen’s kappa were moderate (0.25–0.28) and limits of agreement were wide, indicating moderate agreement. Differences in agreement were associated with the level of consumption and ethnicity, at least for the younger children. Low F&V consumers showed significantly better agreement than did high consumers. At baseline, agreement between parent and child reports for intake of both fruit and vegetables was significantly lower for children of non-Western ethnicity. At follow-up, level of agreement regarding fruit intake no longer differed by ethnicity. For vegetable intake we found an opposite result – agreement between parent and child reports was significantly lower for native Dutch children.

Part III  Evaluation of the Schoolgruiten Project
The primary goal of the Schoolgruiten evaluation study was to assess the effect sizes on F&V intakes and their determinants. The Schoolgruiten intervention was effective in the longer-term in improving fruit intake, as reported by both children and parents, and knowledge of recommended fruit intake levels among boys. No significant effects on vegetable intake were observed. An additional study, described in chapter seven, provided some evidence that the children in the intervention group brought fewer unhealthy snacks and more fruit from home to school to be eaten in the mid-morning break at school. The impact of promoting F&V intakes would be greater if increased intakes of F&V were accompanied by lower intakes of less healthful foods. The results of chapter seven provided some indication that a project aimed at increasing F&V intakes can lead to changes in other nutrition behaviours too.

The longer-term effects were reported in chapter six and showed that the effects on fruit intake were maintained one year after the short-term measurement. Other significant effects that had been observed at one-year follow-up (fruit intake reported by parents, perceived accessibility among children of non-Western ethnicity, parent-reported taste preference of their child among children of non-Western ethnicity) weakened and lost statistical significance at second follow-up.
Unfortunately, we found no significant effects on perceived accessibility, availability or parents’ reported behavioural determinants. Both in the short-term and the long-term, no effects were found on child-reported taste preference for fruit.

Additional analyses in chapter six indicated that the children’s appreciation for the project partly mediated the effect of fruit intake. The children of the intervention group were more likely to appreciate positively a school-based programme promoting F&V intake compared with children of the control group. Furthermore, the children who appreciated the project positively were more likely to have increased their fruit intake. In the final study, described in chapter eight of this thesis, an economic evaluation of the Schoolgruiten and the Pro Children intervention was performed. A comparison was made between the two Dutch interventions and ‘no intervention or doing nothing’. First, future health effects induced by an increased F&V intake were estimated by means of epidemiological modelling. Future intervention effects of the Pro Children intervention, as modelled by the multi-state life table, were estimated at a gain of 326 DALYs/100,000 children (403 DALYs/100,000 boys, 245 DALYs/100,000 girls) over the lifetime of the cohort of all children aged 12 in 2003 in the Netherlands (discounted) (DALY = Disability-Adjusted Life-Years). The future intervention effects for the Schoolgruiten intervention were estimated to be a bit less: 196 DALYs/100,000 children over the lifetime of the cohort (242 DALYs/100,000 boys and 147 DALYs/100,000 girls) of all 12-year-olds in the Netherlands.

Economic evaluations including extensive sensitivity analyses estimated that both the Schoolgruiten and the Pro Children intervention were cost-effective. Using a decision threshold of €19,600, which is equal to the Dutch per capita income, the probability that the Pro Children is cost-effective was 76% and 60% for Schoolgruiten.

METHODOLOGICAL ISSUES

This part of the discussion will address several methodological issues regarding the design of the study and the questionnaires used for the studies presented in this thesis. These issues should be considered when interpreting the findings of the different studies.

Methodological issues related to the research design

Randomisation

The first issue concerning the research design is the randomisation procedure. Although a well-conducted Randomised Control Trial (RCT) is regarded as the ‘gold standard’ to assess the effects of an intervention, it is sometimes considered to be too rigid,
not feasible, or even inappropriate for certain public health settings. Many school-based interventions require multiple, flexible and community-driven strategies. RCTs have been described as unable to accommodate the complexity and flexibility that characterises such programmes. This is because it is very difficult (or maybe impossible) to standardise school-based interventions, because investigators were dependent on different school systems, situations at schools and different teachers. Therefore, it is hardly possible to perform an intervention in exactly the same way in every school. RCTs are perceived as being feasible only for evaluating relatively simple, standardised, and unvarying interventions, and therefore as being too rigid and inappropriate for school settings. In classic RCTs, the intervention is standardised and the individual is the unit of randomisation. When performing interventions in school settings, it is not possible to conduct an individual randomisation, because children in the same class are influenced by each other. Moreover, a part of most interventions is exactly aiming at the whole class or school. Therefore, in school-setting interventions, the school, or class is the unit of analysis.

In addition, such RCTs should preferably be double blinded, which is not possible in school-based interventions and thus is not possible within the Schoolgruiten intervention. Researchers as well as the involved participants were aware of the condition they were in, since the intervention activities were open and obvious. Moreover, the nature of the current intervention made it impossible to conduct random assignment on the level of the individual children. The project addressed the whole school and required changes in the school environment, notably, a fruit break in the classroom. Moreover, children in the same class or school are likely to interact. Ideally, the assignment to the control or intervention condition would have been a randomised procedure. However, in the current study the Dutch Ministry of Public Health, Welfare and Sport had indicated the cities in which the intervention schools were to be located. In order to evaluate the Schoolgruiten intervention, the Schoolgruiten research group selected comparable cities in the neighbourhood of the intervention cities, in which control schools could be recruited. Thus, the assignment to the intervention or control condition was on the city level and could not be based on randomisation. In consequence, the effects of the Schoolgruiten intervention were assessed in a quasi-experimental design, with a pre- and post-test, and an intervention and control group, but without randomisation. Randomisation is used to create equal groups before exposure to the intervention. Since we could not apply randomisation, we tested potential baseline differences between the two groups. Our analyses indeed showed some baseline differences between the intervention and the control group. Notably, both parent- and child-reported baseline vegetable intake was significant higher for the intervention group than the
control group. An explanation could be that there were relatively more children with a non-Western ethnicity in the intervention group than the control group, and these children tend to report a higher vegetable consumption than children from a Dutch ethnicity (chapter 4). In addition, recruiting schools that served as control schools in this intervention study may have led to a selection bias. These schools knew beforehand that they were selected as a control school. As a result, only interested and enthusiastic schools that may have special interest in health behaviours may have been selected, or quite the opposite, i.e., schools that had no interest in pursuing such changes and who were thus happy to be control schools. When the first is the case, it could be possible that these schools had paid special attention to healthy eating. Is so, the effect sizes found may have been attenuated compared to a random assignment. If the second is the case, the effects found may be too positive.

To solve the problem of baseline differences between the two groups, we adjusted all analyses in all studies for baseline differences. However, it may still have affected the results of the intervention negatively since it was more difficult to increase the vegetable intake among the children of the intervention group further compared with the children from the control group. In sum, we did our best to overcome the disadvantages of a quasi-experimental design, but a randomised controlled trial would have been better, especially in terms of the internal validity of the study. However, for the external validity of the study and for the best delivery of the intervention, a RCT had the abovementioned disadvantages. Thus, to ensure optimal exposure of the intervention, the quasi-experimental design used for the evaluation in this study may have been the better design given the circumstances.

Representativeness and generalisability
Seven cities were indicated by the Dutch Ministry of Public Health, Welfare and Sport to implement the Schoolgruiten Project. Because of time and financial constraints, only two of these seven cities could be included in the evaluation study described in this thesis. These were The Hague, a major city in the west of the Netherlands, and Almelo, a medium-sized city in the east. The Schoolgruiten research group selected three control cities in the neighbourhood of the intervention cities; Zoetermeer and Leidschendam close to The Hague, and Hengelo, which is close to Almelo.

Children from the fourth grade (9–10 years) were the target group for the evaluation study. All fourth-grade children from primary schools in the cities were eligible for participation and schools were randomly invited to participate, with initial contact by telephone. The result of the recruitment phase was that 55 schools agreed to participate, ensuring a sample of at least 600 children in both groups. For only one
city (Hengelo), records were kept to assess willingness of schools to participate. Sixteen schools were invited to participate in that city, of which half immediately agreed, four refused and another four had to consult their external school board before confirming participation. Only the eight schools that immediately agreed were included in the study. Similar procedures and rates of agreement were found in the other cities.

The intervention city The Hague is described as one of the ‘big cities’ in the Netherlands. Big cities in the Netherlands have to deal with many serious social and economic problems, such as unemployment and the poverty of certain urban environments. The lower response rate at baseline of the parents from The Hague (58%), in comparison with the parents of the other intervention city Almelo (93%) could be a result of these issues. Response rates at baseline were 91% for the parents of Zoetermeer and Leidschendam and 95% for Hengelo. The fact that the parents in the control cities knew beforehand that they were recruited as ‘controls’ did not negatively influence the response rates of the parents.

The proportion of non-Western immigrants in the total population is highest in the big cities in the Netherlands. Approximately one in three residents of Amsterdam, Rotterdam, and The Hague have a non-Western background and the proportion of second-generation non-Westerners continues to rise. Currently half of the young people residing in the big cities have a non-Western background \(^2\). In other municipalities with more than 100,000 inhabitants this is more like one in ten, and in the smaller towns and villages one in twenty \(^3\). These big cities and their problems and ethnic diversity are quite distinctive and therefore not easy to compare with other cities. In this study, we found similar numbers; in The Hague, 25% of the children had Dutch ethnicity, while in Zoetermeer, and Almelo 65% of the children had Dutch ethnicity. In Hengelo, the large majority (85%) of the children had Dutch ethnicity. The participating children from The Hague seemed representative for the big cities in the Netherlands, and participants from Almelo and Hengelo could be considered as representative for the more rural cities in the Netherlands.

As mentioned earlier, the children of this study had quite a young age at baseline, and therefore they were more likely to overestimate their F&V intakes at baseline. The mean intakes of these children were also quite a bit higher than the mean intakes found in the cross-sectional survey of the Dutch part of the Pro Children Study \(^4\) and the Dutch Vita + Froet Project \(^5\). The children of the Pro Children Study were 11 years old, while the children of the Vita + Froet Project were of the same age as the children of the Schoolgruiten intervention. The children of the Pro Children Study were recruited across the Netherlands, while the children of the Vita + Froet Project were recruited in the southern part of the Netherlands. Since the Schoolgruiten children reported
higher F&V intakes, the results of this study are probably not representative for all Dutch children. Besides, in the current study population, about 40% of the children had a non-Western ethnicity, while in the general Dutch population, aged 0–20 years old this proportion is about 18%. The relative large proportion of non-Western immigrants may also explain that reported F&V intake was higher than in other studies, since non-Western immigrant children consume more F&V.

**Timing of the measurements**

Another issue related to the design of the study is the fact that all follow-up measurements took place while the intervention was still ongoing. As a consequence of this, it was not possible to measure intervention effects over the long-term, after completion of the intervention activities. Consequently, follow-up measurements did not really assess sustained behaviour change without intervention. A design for this study to overcome that issue would obviously have been that the children were followed-up for one year longer, in the absence of any intervention activities. If that design had been applied, we would have been able to measure if an intervention of restricted duration had continuous effects after the intervention activities were completed, and, for example, if the children had adopted increased consumption of F&V as a habit. However, this was not feasible, because in the Netherlands children leave primary school when they are 12 years of age (sixth grade) and home addresses were not available. Nevertheless, the Dutch intervention Vita + Froet showed significant effects (0.2 pieces of fruit per day) in the longer term among 10-year-old children in the absence of any intervention activities in the last year of the programme.

On the other hand, it has been argued that sustained behaviour change can only be realised by sustained environmental changes and promotion communications that make the healthful behaviour ‘easier’, better accepted or even inevitable. The present study showed some effects while the F&V scheme and additional health education was in place, and it is very likely that sustaining such effects can only be realised if a supportive F&V environment is also maintained, in this case in secondary school.

**Methodological issues related to the data collection procedure - questionnaire**

In the studies reported in this thesis, we developed our own questionnaires. These questionnaires were based on and very similar to the validated questionnaires used in the Pro Children Study. As part of the European Pro Children Project, several validation studies were performed and showed satisfactory results regarding validity, reliability, and reproducibility. Still, further improvements of intake measures that can be used in large population-based studies are needed, because neither parents nor children...
proved to be adequate reporters of children’s food intake. This topic is, of course, much larger than just related to the study at hand. Valid measurement of food intake is an issue that relates to all research into nutrition behaviours, determinants of such behaviours and effectiveness of nutrition interventions. Although we did not use a validated questionnaire, it appears that we were able to measure determinants of F&V quite well, because our results were consistent with findings from recent reviews about determinants of F&V intake among children, which suggested good construct validity. Nevertheless, it may still be that children overestimated their own F&V intake, as shown in chapter four. We only assessed this for children of the control groups, but expect that the same will apply for children of the intervention group, but it might be that the children in the intervention group were more aware of their F&V intake caused by participation in the intervention. If this were true, then the children of the intervention group would be expected to report more realistic intake levels at follow-up than the controls.

Unfortunately, the Schoolgruiten questionnaire did not include as many potential correlates as the Pro Children questionnaire. The Pro Children Study questionnaire included a wide range of measures of personal, social environmental, and perceived physical environmental determinants that may influence F&V intakes. In order to limit the number of questions, it meant that most constructs had to be assessed with only one or a few questionnaire items. In questionnaire development there is always a trade-off between precision and extensiveness in measurement of potentially important determinants and the wish to include measures of as many potentially important determinants as possible. Although the Schoolgruiten questionnaire included fewer constructs than the Pro Children questionnaire, the constructs were still measured with only one or two items. Including more items per construct could have increased the internal consistency of the scales and the construct validity and possibly the sensitivity to detecting changes of the measurement. On the other hand more questions might have been a barrier for school-based administration, and may also have confused the children.

As with all self-reported questionnaires, answers to questions about food intake (F&V intake) and determinants of food intake (F&V intake) may be liable to social desirability. We were not able to adjust for this possible confounding factor, as a tendency to give socially desirable answers was not assessed. However, we tried to minimise social desirability for both children and parents by stressing that there were no right or wrong answers. For the parents, this was written in the introduction of the questionnaire and for the children, the teacher who guided the children with filling in the questionnaire emphasised this.
EXPLANATIONS OF FINDINGS

Part I Determinants of schoolchildren’s fruit and vegetable intakes
We found that taste preference, knowledge, availability, and accessibility were the most important determinants of F&V intake. Behavioural models, such as the Theory of Planned Behaviour (TPB), propose that attitude, social norm, perceived behaviour control and intention predict behaviour. However, these variables were not identified as the most important determinants in the current study. This suggests that F&V intake among children cannot be considered as very reasoned or planned action, but might be a more automatic or ‘mindless’ unconscious behaviour. This idea is supported by the finding that availability and accessibility were identified as important correlates. The Environmental Research framework for weight Gain prevention (EnRG model) can also explain these findings. In this framework, behaviour is postulated to be a result of a concurrent influence of both conscious and unconscious processes. Therefore, environmental influences are proposed to have both direct and indirect effects on health behaviour. The indirect causal mechanism reflects the mediating role of behaviour-specific cognitions in the influence of the environment on behaviour. A direct influence reflects the autonomic influence of the environment on the specific behaviour. An environment that offers many opportunities to consume F&V may result in higher consumption of F&V. Availability and accessibility are examples of such environmental factors.

Part II Measurement issues of intake
Results of the second part of this thesis on the agreement between parents and children on the reported F&V intakes are consistent with other studies. Reinaerts et al. also found a low level of agreement between children’s and parents’ reports. Another study showed that both parents and children inaccurately estimate portion sizes. Our study indicates that the young age of the children is one explanation for the low level of agreement between parents and children, because agreement improved with age. It has been found before that younger children are not able to report adequately on their eating behaviour, probably due to cognitive developmental issues and limited food experience.

As mentioned before, children are likely to be influenced in their eating behaviour by home-environmental factors such as food availability and accessibility at home, and parental example behaviour, rules and support. Parents are regarded as of key importance. Unfortunately, in the current study the perceptions of such home and parent-related factors differed between parents and children, making it hard to assess...
the ‘true’ home environment. This has been reported in previous studies as well \cite{18,20,21}, and indicates that parents and children may perceive the child’s food environment very differently.

Part III   Evaluation of the Schoolgruiten Project

Effect sizes from the Schoolgruiten intervention are comparable to those found in other comprehensive school-based intervention studies conducted in the USA \cite{14,22-24} and in Europe \cite{25,26}. Not all of these studies looked at F&V separately. The effects for Schoolgruiten were mostly restricted to fruit intake. Another Dutch intervention programme did find effects on vegetable intake specifically \cite{5}, but in the Pro Children evaluation study, effects were also more pronounced for fruits \cite{25}. In the Netherlands, compared with other countries, it may be difficult to increase vegetable consumption via a school-based intervention programme. No school meals are offered in Dutch primary schools, which makes promotion of vegetable consumption during school hours a challenge. In a country like Sweden, where school meals are offered, a higher consumption of vegetables compared with Dutch children, at schools is possible \cite{4}. To increase vegetable consumption among Dutch children, involvement of the parents is of key importance, because within Dutch eating habits, vegetables are eaten at the main meal, mostly in the home setting, and bringing vegetables to school would require a major change in eating habits. As part of the Schoolgruiten program, fruit as well as ready-to-eat vegetables were handed out in schools, but this did not lead to a significant increase in vegetable intake.

Our results showed long-term effectiveness for fruit intake despite the fact that the same curriculum was not used in every school. The RE-AIM model suggests that the true effectiveness of an intervention is dependent on its Reach, Efficacy, Adoption, Implementation, and Maintenance. The fact that the curriculum was adopted and implemented sub-optimally suggests that there is room for improvement in the conditions for effect, and thus for higher effectiveness.

As mentioned before, we found small but significant effects on fruit intake at second follow-up (child reports, 0.15 pieces fruit per day more; parent reports, 0.19 pieces fruit per day more). This amount is about equal to (slightly lower than) the total weekly amount of fruit provided for free at school. The children received one piece of fruit or vegetable twice per week, which equals 0.29 pieces of fruit/vegetable per week. This means that children improved less than might have been expected based on the F&V scheme. This suggests compensation with fruits they used to eat before the F&V scheme started.
The net effects of the intervention were small, but might have been attenuated as discussed before. Still, it remains questionable whether such small increases will lead to public health benefits. Public health benefits do not solely depend on effect sizes but also on the population reached by the intervention and on the sustainability of the intervention effects. In order to estimate future health effects induced by an increased F&V intake, epidemiological modelling was applied. The modelling assumed that the intervention was implemented nation-wide and that 30% of the effect was sustained. Modelling results indeed showed that the intervention might lead to public health benefits under the conditions mentioned. The future intervention effects for the Schoolgruiten intervention were estimated to be 196 DALYs/100,000 children over the lifetime of the cohort (242 DALYs/100,000 boys and 147 DALYs/100,000 girls) of all 12-year-olds in the Netherlands. In another study about annual health gain due to computer-tailored health promotion, if the total Dutch population aged 25 and over are reached, DALYs of 141 for men (DALYs gained per 100,000 person-years) and 105 for women (DALYs gained per 100,000 person-years) were estimated. Despite the relatively small intervention effects and an assumed low sustainability, an intervention like Schoolgruiten may have relevant public health benefit, which is probably due to the broad reach. In addition, the economic evaluation including extensive sensitivity analyses estimated that the Schoolgruiten intervention was cost-effective, assuming willingness to pay €19,600 per DALY. To calculate the costs, the total health care costs between the intervention group and the control group plus the implementation costs of the intervention were included, and subsequently divided by the DALYs saved by the intervention.

**IMPLICATIONS**

The results presented in this thesis have several implications for future research and practice. Recommendations for future research are related to questions that still remain unclear after completing the present thesis. Recommendations for practice are related to the implementation and continuation of the use of the Schoolgruiten intervention and similar interventions aimed at schoolchildren in the future.
IMPLICATIONS FOR FUTURE RESEARCH

Part I  Determinants of schoolchildren’s fruit and vegetables intakes

Results of chapter two indicated that a wide range of possible determinants are associated with children’s F&V consumption. The overview of studies indicated that motivational factors, such as preferences, are most strongly related to F&V intake among children. Further, differences in preferences explained the gender differences in F&V intake levels. Other studies have indicated that home-environmental factors and especially parental influences are of key importance too. However, which potential determinants of F&V are crucial in interventions, that is, which determinants are important for changes in F&V intakes, needs further research. Such research should go beyond cross-sectional and longitudinal associations, and should look into moderators and mediators of intervention effects and longitudinal changes in F&V intakes. In the present thesis, some preliminary work in this field was reported. In chapter three different associations between F&V intake and its determinants were investigated in a longitudinal design. To our knowledge, no other studies have investigated the association between changes in determinants and changes in F&V intake among children in different time intervals. Therefore, our findings need to be replicated in future studies. Accordingly, it is necessary to conduct more longitudinal research on determinants of F&V intake, but maybe with shorter time intervals than we have used, because if such intervals are too long, various changes in potential determinants and behaviours may have occurred that were not detected. The study reported by De Vet et al. among an adult population is an example of frequent assessment of potential determinants and behaviours with different time intervals that allow a more in-depth exploration of mediators and moderators of changes in dietary intakes. Conducting such a study in a young population will be challenging.

Part II  Measurement issues of intake

In part two of this thesis, we showed that for the evaluation after two years, it did not make much difference whether parents or children themselves reported their F&V intake. In the short term, however, effect estimations were dependent on whether child or parental reports were used for assessment of F&V intakes. In future studies, the source of data should therefore at least be mentioned and preferably both parental and child reports should be used. That both reports show similar results and effects may be regarded as an indicator of reliability and thus more robust evidence. Because we found evidence that children in the fourth grade (10 years old) tend to overestimate their own intake, we recommend not using such self-report questionnaires among children that
are 10 years or younger. When evaluating interventions for such younger age groups, researchers are dependent on the parental reports or should use other instruments, for example, observation. However, parents are also likely to be biased reporters of their child’s food intake. New ways thus need to be explored, and combining parental reports based on a more traditional food frequency questionnaire with other forms of child reports may still be advisable because among parents there is often a large dropout and potential selection bias. Therefore, in future research, efforts must be made to develop measures that are appropriate for younger children. An example of an attempt to develop such a measure is the ‘Day in the Life’ questionnaire developed by Edmunds et al. This questionnaire was developed as a supervised classroom exercise to measure children’s (7–9 years old) F&V intake using words and pictures. The questionnaire showed good to acceptable validity, reliability, and sensitivity. If these kinds of measures are available, interventions can be evaluated using both parental and child reports and this will strengthen the evidence collected.

That parents perceived the potential family determinants of their child’s intakes (such as availability of F&V at home and exposure to F&V) more positively than did their children has implications for intervention development. It is important to undertake special efforts to make the parents aware of the inconsistencies and the fact that their children may see or interpret their efforts and the home environment differently from themselves. This should lead them to increase their efforts to create a supportive family and home environment for healthy eating.

Part III Evaluation of the Schoolgruiten Project

In this thesis, we were able to show that the Schoolgruiten intervention was effective in changing intake of fruit. Regarding the potential determinants of F&V intake, we only found significant effects on knowledge of recommended intake levels among boys. As we expected that the intervention would work through the determinants addressed by the intervention, it is not completely clear how the intervention worked. As suggested previously, the changes in environmental factors (availability) may have directly affected the F&V consumption, but it may also be that it worked through other determinants that we did not consider. Alternatively, it may have been that our instruments were not sensitive enough to detect changes in determinants. Therefore, future studies should use better instruments to measure a wider range of determinants and conduct proper mediation analyses in order to explore how the intervention worked. Mediation analyses can be helpful in exploring causal pathways. In the Schoolgruiten intervention, knowledge of recommendations was identified as a relevant correlate of intake. Additional analyses showed that knowledge of recommended intake levels of fruit
among boys partly mediated the intake of fruit. Adding knowledge of recommended intake levels into the model, the regression coefficient decreased from 0.15 to 0.11 (28.8%).

To explain differences in F&V intakes some mediation analyses have been conducted in other studies. A study by Bere et al. found that perceived accessibility was a strong mediator in the relationship between parental socio-economic position and adolescents’ F&V intake. Accessibility may therefore be an important target for future interventions to reduce socioeconomic disparities in adolescents’ F&V intake. In another study, preference appeared to be a strong mediator of the difference in F&V intakes between boys and girls. More mediation analyses need to be conducted to gain more insight into causal pathways.

We would also recommend conducting moderation analyses. Moderation analyses might be helpful to gain more insight into for whom the intervention works and for whom it does not, and such insights can help to target and tailor the intervention better to the right subgroups. Potential moderators of intervention effects are rarely tested, and often only interaction effects with gender, educational level, and race/ethnicity are assessed. In chapter five, we investigated the short-term intervention effects separately for native Dutch children and Dutch children of non-Western ethnicity. In these analyses, we found significant intervention effects for fruit intake for native Dutch children and not for children with a non-Western ethnicity. To the contrary, significant intervention effects for vegetable intake for children with a non-Western ethnicity were found and not for native Dutch children.

Bere and colleagues performed different moderation analyses as well. They investigated four potential moderators of the F&V intervention effect; gender, parental education level, household income, and habitual F&V intake, but none of these came out as significant moderators. Also, Te Velde et al. performed moderation analyses for a multi-component international F&V intervention. They included gender and country as potential moderators, and found country to be a significant moderator of the intervention effect on fruit intake at long-term follow-up; the intervention worked better in Norway than in Spain and the Netherlands. Still, more research is needed into potential effect modifiers, such as socio-economic position.

The Schoolgruiten intervention was not primarily developed to decrease the consumption of unhealthy snacks, but some evidence was found that the Schoolgruiten intervention was associated with a decrease in the consumption of unhealthy snacks during the mid-morning break at school. It further indicates that restricted access to unhealthy snacks may play an important role in reducing the consumption of unhealthful snacks during school breaks. It is necessary to conduct more research on
possible positive and negative compensation behaviours in the promotion of healthy eating as well as into the effects of environmental and policy changes in primary schools.

Current initiatives to promote F&V intake among children are based on preliminary evidence from observational studies which indicated that high intakes of F&V contribute to cancer prevention. However, more recent and robust studies indicate that the inverse association between F&V intake and cancer risk is much weaker than the initial studies suggested. If the public health benefit of high fruit (and juice) intake is not as large as was initially believed, such benefit may not outweigh the potential adverse effects of fruit and fruit juice consumption. Frequent fruit and fruit juice consumption will contribute to higher risk of tooth decay. The sugar content of fruit juice is similar to or higher than that of sugar-containing soft drinks, and frequent juice intake may thus contribute to excessive calorie intake. On the other hand, promotion of F&V consumption may aid obesity prevention because F&V have lower energy density than many other foods, especially when compared with sweet and savoury snack foods. Earlier research into the association of F&V intakes with overweight and obesity shows ambivalent results. Therefore, future research should clarify the advantages and disadvantages of increased fruit (juice) consumption, taking possible compensation behaviours into account.

Based on the results of this thesis and other research on distribution programmes, we conclude that distribution of F&V at primary schools has high potential. Therefore, a first attempt has been made in the implementation of the Schoolgruiten intervention. Three different implementation models will be tested and evaluated. The first model is the ‘delivery’ model, where a distributor delivers F&V to a school once a week. The second model is the ‘take-away’ model, in which school employees or volunteers go to the distributor once a week and bring the F&V to school. The third model is called the ‘bring to school’ model and in this model school policy prescribes that parents are obliged to give their children F&V to bring to school twice a week. The results of this implementation study will show which model is most promising in terms of reach, implementation, and costs.

In the United Kingdom, the Food Dudes Healthy Eating Programme has been developed and extensively tested with thousands of children aged 2-11 in homes, nurseries and primary schools and it has been shown in every case to be highly successful in getting children to eat F&V. The results of the studies to date indicate that the Food Dudes Healthy Eating Programme works very well in primary schools and brings about substantial increases in pupils’ consumption of F&V. This programme aims to encourage children to eat F&V both at school and at home. The programme consists of two phases.
In the first phase children have to read a Food Dudes letter about F&V each day. The children are then given a portion of fruit and a portion of vegetable and those who succeed in eating both the fruit and vegetable are given a small reward. The rewards are used at the beginning of the programme to encourage children to repeatedly taste F&V repeatedly so that they begin to enjoy the taste of the foods. Children are also provided with a Food Dudes Home Pack, the aim of which is to encourage children to eat more F&V at home through the involvement of parents and a system of self-monitoring. In phase two the programme continues to support successful eating of F&V, but with less intensity than during the first phase. Classroom Wall Charts are used to record the consumption levels of these foods, and as the children achieve more advanced goals they earn further rewards and Food Dudes certificates. After this successful pilot phase in the United Kingdom, the Irish Government decided to introduce Food Dudes to every primary school in the country. This national roll-out is now underway and is proving both successful and very popular. Also, England started a roll-out in selected regions (Wolverhampton, Bedford, and London) from January 2009. The Government’s School Food Trust (Department of Health) and other organisations support this.

In 2008, the European Union (EU) introduced policy and funding to implement school F&V schemes as part of EU agricultural policy. European funds worth €90 million every year will pay for the purchase and distribution of fresh F&V to schools. This money will be matched by national and private funds in those member states which chose to implement the programme. The school fruit scheme aims to encourage good eating habits in young people, which studies show tend to be carried on into later life. Besides providing F&V to a target group of schoolchildren, the scheme will require participating member states to set up strategies including educational and awareness-raising initiatives and the sharing of best practice. The scheme will begin at the start of the 2009/2010 school year.

**IMPLICATIONS FOR PRACTICE**

Based on the first part of this thesis, it can be concluded that interventions aimed at increasing schoolchildren’s F&V intake should focus on personal factors, such as improving taste preferences for F&V, and enhancing knowledge of recommended daily intake levels of F&V intakes. In the physical environment, availability of F&V at home and at school should be targeted. The results of this intervention study suggest that improving accessibility and availability of F&V at school is an effective strategy to increase fruit intake among primary schoolchildren.
General discussion and conclusion

One way to address different determinants is through the school curriculum, which can focus, for example, on personal determinants, such as knowledge of recommended intake levels. Unfortunately, in the current study we showed that exposure to the school curriculum was much lower than was aimed for. Therefore, it is important to improve the adoption, implementation, and maintenance of the school curriculum. Ways of improving this can be, for example, by hiring special staff or integrating the project into the regular school curriculum. The latter has the advantage that it does not involve extra personnel costs.

However, the present studies also indicate that the increased consumption may lead to changes in preferences and knowledge. Further, applying more ‘mindless’ intervention schemes may be the way forward, not least because these do not take time out of the regular school curriculum.

In order to improve the intervention effects on vegetable intake, it is important to get more parents involved, because parents play an important role in preparing the main meal and making vegetables available and accessible for their children. Strategies to involve parents are, for example, the use of newsletters, and homework assignments for both parents and their children to perform together. However, most school-based interventions struggle with low parent participation despite attempts to realise this, and more research is needed to identify determinants of better parent involvement.

The recently started EU study, called ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth: Theory and evidence-based development and validation of an intervention to promote healthy nutrition and physical activity) will indeed specifically focus on this. It will conduct focus group interviews with parents and a literature search to find determinants of parental involvement. Subsequently, these findings will be translated into new intervention strategies to be tested in a pilot study.

GENERAL CONCLUSION

Both of the studies in part I of this thesis revealed that intake of F&V was associated with personal, social environmental, and physical environmental factors. The studies confirm that children's eating behaviour is complex and determined by multicausal determinants, of which taste preference, accessibility, and availability are very important.

Based on the study described in part II of this thesis, we conclude that self-report questionnaires on food frequency should not be used among children younger than
11 years. It advisable to include both parent and child reports in evaluations of school-based interventions.

Based on the studies described in part III of this thesis, we conclude that the Schoolgruiten intervention can be an effective and cost-effective way to contribute to increased fruit intake, which may be accompanied by some decrease in the amount of unhealthy snacks eaten.

**REFERENCE LIST**


General discussion and conclusion


(43) Wind M. Pro Children; The development, implementation and evaluation of a school-based intervention to promote fruit and vegetable intake among 10–13 year-old European schoolchildren. Erasmus Medical Center Rotterdam, the Netherlands; 2007.
Summary
SUMMARY

Consuming sufficient amounts of fruit and vegetables (F&V) may contribute to prevention of several chronic diseases. Nevertheless, most children in Western countries, including the Netherlands, do not comply with recommendations for F&V intake. Therefore, several F&V promoting interventions have been implemented. One of these interventions is the large-scale Dutch Schoolgruiten Project. ‘Schoolgruiten’ is a Dutch acronym for ‘school fruit and vegetables’. The Schoolgruiten Project is planned to grow into a nationwide campaign for primary schoolchildren, but it started with a pilot phase in which the intervention was tested in a controlled design. This pilot phase is described in the present thesis.

The first part of this thesis (chapters two and three) describes two studies on potential determinants of F&V intake. The second part (chapter four) is chapter on methodological issues. It describes the questionnaire used to assess F&V intake among children and tests the agreement between parent and child reports of the children’s F&V intake levels. The last part of the thesis (chapters five to eight) describes the impact evaluation and economic evaluation of the Schoolgruiten intervention. The thesis concludes with a summary and an integration of the main findings in chapter nine, as well as a discussion of the methodological issues and implications for future research and practice.

The main strategy of the Schoolgruiten intervention was to improve accessibility of F&V at school, which is one of the main determinants of F&V intake among children. The children of the intervention group received a free serving of fruit or ready-to-eat vegetables twice a week at school. Additionally, a school curriculum aiming at increasing knowledge and skills related to F&V consumption was offered to the schools.

To evaluate the effect of the Schoolgruiten intervention, a pre-test and two post-test measurements were conducted. Both schoolchildren (aged 9 years old at baseline) and their parents filled in questionnaires about the child’s intake and determinants of intake, which gave us the opportunity to perform all analyses on both parent and child reported data.

Chapter two gives an overview of the presumed most important determinants of F&V intake among schoolchildren, with a specific emphasis on taste and taste preferences, based on reviews of the literature and results from two specific studies. Results from the two studies revealed that taste preferences and liking of F&V, a positive attitude
for F&V, knowledge of recommended daily intakes of F&V, positive self-efficacy for F&V, positive role modelling for F&V, family rules for eating F&V, parental facilitation of F&V, and availability at home of vegetables were important potential determinants of intake. These factors seemed to be of greater importance for fruit intake than for vegetable intake.

In **chapter three** we investigated whether changes in F&V intake frequency and changes in potential determinants measured at three different time points were associated. For this study, we additionally used data of the Dutch part of the European Pro Children Study, an intervention study among primary schoolchildren to promote F&V intakes. Both longitudinal and cross-sectional analyses showed that positive changes in important determinants (taste preferences, self-efficacy, family rules and availability at home) were associated with positive changes in F&V intakes. Changes in F&V intake were also associated with changes in taste preferences and knowledge of recommendations later in time. These findings support theories proposing direct and indirect reciprocal associations between determinants and behaviour.

Because it was not clear from the literature whether child or parent reports of the child’s intake are the most valid regarding intake levels, a study (described in **chapter four**) investigated the level of agreement between child and parent reports of the child’s F&V intake and their determinants. Weighed Cohen’s kappa were moderate and limits of agreement were wide, indicating moderate agreement between child and parent reports on child’s F&V intake. Moreover, agreement was worse among boys and among non-Western immigrant children. The weak to moderate agreement was dependent on the age of the child, since disagreement was stronger for fourth graders than fifth graders. Fourth graders tend to overestimate their own intake of F&V. Differences in agreement seemed further to be dependent on level of consumption and ethnicity, at least for the younger children.

In **chapters five and six**, we investigated the short- and long-term effects of this intervention on F&V intake and their determinants. Short-term effect evaluation showed positive mixed results, namely a significant higher vegetable intake for children of non-Western ethnicity than their peers from the control schools. The Dutch children from the intervention schools reported significantly higher fruit intake than the Dutch children from the control schools. No significant effects in intake were observed based on parent-reports. Significant positive intervention effects were also found for perceived accessibility among children of non-Western ethnicity, and for parent-reported taste
preference of their child among children of non-Western ethnicity and among boys of Dutch ethnicity.

Chapter six describes the long-term effects. Both children and parent reports indicated that the intervention group had a significantly higher fruit intake at second follow-up. Significant positive intervention effects were also found for knowledge of fruit recommendations among boys. Further, we explored whether children’s appreciation of the project could explain these intervention effects. After different analyses, we concluded that appreciation of the project partially mediated this effect. This suggests that children should be consulted in the development of school-based interventions so that interventions are developed that are appreciated by the children.

In chapter seven, we investigated if the Schoolgruiten intervention could contribute to increasing F&V intake, and/or to replace unhealthy snacks by a piece fruit or vegetable in the mid-morning break at school. Results indicated that children in the intervention group brought F&V snacks more often and unhealthy snacks less often from home to school to consume in the morning break at school. We found this result in both the child data and in the parent data.

In chapter eight, an economic evaluation of the Schoolgruiten and the Pro Children Study is described. A comparison was made between these two Dutch interventions and ‘no intervention or doing nothing’. First, future health effects induced by an increased F&V intake were estimated by means of epidemiological modelling. Future intervention effects of the Pro Children intervention as modelled by the multi-state life table were estimated at a gain of 326 DALYs/100,000 children (DALY = Disability-Adjusted Life-Years). The future intervention effects for the Schoolgruiten intervention were estimated to be a bit less: 196 DALYs/100,000 children. Economic evaluations including extensive sensitivity analyses estimated that both the Schoolgruiten and the Pro Children interventions were cost-effective.

The final chapter (chapter 9) describes and discusses the main findings of the eight chapters of this thesis. Furthermore, some methodological issues of all seven studies are addressed, and implications for future research and practice are discussed.

One of the overall conclusions of the Schoolgruiten project is that this intervention is effective in increasing children’s fruit intake. Although effect sizes were small, a scheme that improves availability of F&V in school appears to be an effective way to increase
intake levels of fruit. Environmental factors such as availability and accessibility of F&V are important determinants of F&V intake among primary schoolchildren and should be targeted in interventions.
Samenvatting
SAMENVATTING

Het wordt algemeen aangenomen dat het eten van voldoende groenten en fruit (G&F) goed is voor de gezondheid, met name voor het voorkomen van bepaalde kankertypes, hart- en vaatziekten en overgewicht. In de meeste westerse landen, inclusief Nederland, consumeren zowel kinderen als volwassenen dagelijks minder dan de aanbevolen 200 gram groenten en twee stuks fruit. In Nederland zijn er daarom diverse G&F interventies ontwikkeld met als doel de G&F inname van kinderen te verhogen. Eén van deze interventies is het grootschalige Schoolgruiten Project. Gruiten is een samenvoeging van groenten en fruit. Het uiteindelijk doel is om het Schoolgruiten Project in Nederland op alle basisscholen te implementeren, maar er is eerst gestart met een pilot studie om het effect van de Schoolgruiten interventie te onderzoeken in een gecontroleerd design. De resultaten van deze pilotstudie worden in dit proefschrift beschreven.

In het eerste deel van het proefschrift (hoofdstuk twee en drie) wordt beschreven welke factoren van invloed zijn op de G&F consumptie van kinderen. Het tweede gedeelte (hoofdstuk vier) is een meer methodologisch hoofdstuk. Dit hoofdstuk beschrijft in hoeverre de kinderrapportages en de ouderrapportages betreffende de G&F consumptie van het kind overeenkomen. Het laatste deel van dit proefschrift (hoofdstuk vijf tot en met acht) is gericht op de effect- en economische evaluatie van de Schoolgruiten interventie. Het proefschrift wordt afgesloten met een weergave van de belangrijkste bevindingen (hoofdstuk negen), alsook een discussie van de methodologische beperkingen, implicaties voor toekomstig onderzoek en de praktijk.

en is een interventiegroep met een controlegroep vergeleken. Kinderen uit groep zes en hun ouders hebben tijdens de voormeting vragenlijsten ingevuld. Aan de hand van deze vragenlijsten werd inzicht verkregen in de dagelijkse G&F consumptie van het kind en mogelijk belangrijke beïnvloedende factoren van de G&F consumptie. Deze vragenlijsten zijn tijdens de twee nametingen opnieuw ingevuld door dezelfde kinderen en hun ouders. Dit gaf ons de mogelijkheid om de analyses uit te voeren op zowel de kinder- als de ouderdata.


In **hoofdstuk drie** is gekeken naar het verband tussen verandering in mogelijke determinanten van de G&F consumptie en verandering in de consumptie van G&F. Voor deze studie is ook gebruik gemaakt van de Nederlandse data van de Europese Pro Children studie, eveneens een interventiestudie met als doel het verhogen van de G&F consumptie van basisschoolkinderen. Resultaten lieten zien dat positieve veranderingen in determinanten (smaakvoorkeur, eigen-effectiviteitsverwachting, regels van de ouders betreffende het eten van G&F en beschikbaarheid van G&F in de thuissituatie) waren geassocieerd met positieve veranderingen van de G&F consumptie in dezelfde tijdsperiode. Ook werd gevonden dat positieve veranderingen in determinanten vooraf gingen aan positieve veranderingen van de G&F consumptie. Daarnaast vonden we dat positieve veranderingen van de G&F consumptie vooraf kon gaan aan positieve veranderingen van de smaakvoorkeur voor G&F. Deze bevindingen ondersteunen veel gebruikte gedragsveranderingstheorieën die veronderstellen dat verandering van determinanten vooraf gaat aan verandering van gedrag (G&F consumptie). Daarnaast
ondersteunt het recente ideeën dat verandering van gedrag ook tot verandering in mogelijke determinanten kan leiden.

In de literatuur is weinig bekend over de overeenstemming tussen ouder- en kindrapportages voor het meten van de G&F consumptie van het kind. Daarom is een studie uitgevoerd, beschreven in hoofdstuk vier, waarin de mate van overeenstemming tussen kind- en ouderrapportages betreffende de consumptie van G&F van het kind en de determinanten van G&F consumptie is onderzocht. Kinderen rapporteerden gemiddeld een hogere consumptie van G&F dan hun ouders deden. Er bleek dus een matige overeenstemming te zijn tussen kind- en ouderrapportages. Bovendien was de overeenstemming slechter bij jongens dan bij meisjes en bij kinderen met een niet-westerse achtergrond in vergelijking met Nederlandse kinderen. De mate van overeenstemming was verder afhankelijk van de leeftijd van het kind, aangezien overeenstemming beter was bij kinderen uit groep zeven dan bij kinderen uit groep zes. Verschillen in overeenstemming bleken verder afhankelijk te zijn van de hoogte van de consumptie van G&F; overeenstemming was beter voor diegenen die een lagere inname rapporteerden.

In de hoofdstukken vijf en zes, zijn de korte en lange termijn effecten van de Schoolgruitendel interventie op zowel de hoogte van G&F consumptie als op de belangrijkste determinanten van G&F consumptie onderzocht. Gebaseerd op de vragenlijsten ingevuld door de kinderen, liet de evaluatie op korte termijn (na één jaar interventie) positieve significante resultaten zien van de inname van groenten bij de kinderen met een niet-westerse achtergrond, in vergelijking met de niet-westerse kinderen uit de controlegroep. De Nederlandse kinderen uit de interventiegroep rapporteerden een significant verschil voor fruit in vergelijking met de Nederlandse kinderen uit de controlegroep. Er werden geen interventie-effecten voor de G&F consumptie gevonden wanneer de ouderrapportages werden gebruikt. Significante positieve interventie-effecten werden ook gevonden voor waargenomen toegankelijkheid tot G&F bij de kinderen met een niet-westerse achtergrond en ouders rapporteerden een positievere smaakvoorkeur voor fruit bij hun niet-westerse kind en bij Nederlandse jongens.

In hoofdstuk zes worden de lange termijn effecten beschreven. Zowel de rapportages van de kinderen als die van de ouders lieten zien dat de interventiegroep een hogere inname van fruit had dan de controlegroep op de tweede nameting. Significante positieve interventie-effecten werden ook gevonden bij jongens voor kennis van de dagelijks aanbevolen hoeveelheden van de consumptie van G&F. Aanvullend hebben
we onderzocht of de waardering voor een interventie gericht op het bevorderen van G&F consumptie de interventie-effecten konden verklaren. Kinderen uit de interventiegroep hadden een hogere waardering voor een project waarbij G&F op school zouden worden uitgedeeld en dit verklaarde waarom zij een significant verschil lieten zien van hun G&F consumptie in vergelijking met de kinderen uit de controle-groep. Dit betekent dat kinderen bij de ontwikkeling van interventies uitgevoerd op school moeten worden betrokken en geraadpleegd, omdat waardering voor de interventie belangrijk is bij het optimaliseren van interventie-effecten.

**Hoofdstuk zeven** beschrijft een onderzoek of de kinderen uit de interventiegroep vaker G&F en minder vaak ongezonde snacks meenemen van thuis voor te consumeren tijdens de ochtendpauze dan de kinderen uit de controle-groep. Uit de analyses bleek dat kinderen uit de interventiegroep inderdaad vaker G&F meenamen als tussendoortje voor tijdens de ochtendpauze op school en minder vaak ongezonde snacks. We hebben dit resultaat op basis van zowel de ouder- als de kindrapportages gevonden.

In **hoofdstuk acht** is een economische evaluatie van het Schoolgruiten Project en de Pro Children Studie beschreven. Een vergelijking is gemaakt tussen deze twee interventies en ‘geen interventie of niets doen.’ Eerst zijn de toekomstige gezondheidseffecten door de toename van G&F consumptie geschat door middel van een epidemiologisch model. Toekomstige interventie-effecten van de Pro Children interventie, werden geschat op 326 DALYs per 100.000 kinderen. DALYs staat voor Disability-Adjusted Life-Years en is een maat waarin zowel sterfte als prevalentie en ernst van ziekten worden samengevat. De toekomstige interventie-effecten voor Schoolgruiten werden iets lager geschat: 196 DALYs per 100.000 kinderen. In de economische evaluaties is een afweging gemaakt tussen de kosten en de gezondheidswinsten op lange termijn en is rekening gehouden met een bedrag dat men bereid is te betalen voor 1 DALY winst. Rekening houdend met deze aannames werd er geschat dat zowel Pro Children als Schoolgruiten kosteneffectief waren.

In het laatste hoofdstuk van dit proefschrift, **hoofdstuk negen**, worden de belangrijkste resultaten van de zeven studies uit dit proefschrift samengevat en bediscussieerd. Methodologische aspecten en beperkingen met betrekking tot de opzet van de studie, de representativiteit en van de dataverzameling worden besproken. Tot slot worden implicaties voor verder onderzoek, alsook voor de praktijk, besproken.
Eén van de belangrijkste conclusies na het voltooien van dit proefschrift is dat de Schoolgruiten interventie kan bijdragen aan het verhogen van de fruitinname van basisschoolkinderen. Hoewel de gevonden verschillen klein waren, lijkt het verhogen van de beschikbaarheid van fruit op school, een effectieve manier om de fruitconsumptie bij kinderen te verhogen. Omgevingsfactoren, zoals toegankelijkheid en beschikbaarheid van G&F, zijn belangrijke determinanten van G&F consumptie van basisschoolkinderen en moeten dus worden verbeterd in toekomstige interventies.
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Liefs Nannah

Noah
About the author
Nannah Iefke Tak was born on October 24, 1979 in Gouda, the Netherlands. After graduating from secondary school (HAVO) at the Huygens Lyceum in Voorburg in 1998, she started her study Nutrition and Dietetics at the Haagse Hogeschool, The Hague. She wrote her thesis about the Protein Catabolic Rate and haemodialysis patients at the Academic hospital Maastricht. In 2002 she received the Novartis Diëtetiek Award for her bachelor thesis. In the same year, she started her Master study in Nutrition and Health at the Wageningen University, with the specialization Dietary Behaviour behaviour and disease prevention. She wrote her thesis about the Dutch project Schoolgruiten with the subject: Differences between fruit and vegetables consumption between native Dutch children and children of non-Western immigrants. In 2004 she received her Master of Science degree (in Health and Nutrition).

In March 2005 she started working as a junior researcher at the department of Public Health at the Erasmus Medical Center, Rotterdam. In May 2007 she came to the EMGO Institute at the VU Medical Center, Amsterdam together with the transfer of Hans Brug and Saskia te Velde. The research performed during these two jobs is described in this thesis. In 2009, she received the EMGO+ Societal Impact award for her work on the evaluation of fruit and vegetable schemes in primary schools. Nowadays, she still works at the EMGO Institute for Health and Care Research on a project about environmental and individual factors in the explanation of overweight and obesogenic behaviors.
List of publications
First author papers

- Tak NI, Te Velde SJ, Singh AS & Brug J. The effects of fruit and vegetable promotion intervention on snacking during school breaks. Results of the Dutch Schoolgruiten Project. Resubmitted for publication
- Tak NI, Te Velde SJ, Oenema A, Van der Horst K, Timperio A, Crawford D & Brug J. Mediation by cognitive factors and habit strength of the association between home environmental variables and soft drink consumption among adolescents. Submitted for publication

Co-authors papers

- Te Velde SJ, Veerman L, Tak NI, Bosmans JE & Brug J. Long term health outcomes and cost-effectiveness of two school-based interventions promoting fruit and vegetable intake among 11-year-old Dutch children. Submitted for publication
- Prins RG, Van Empelen P, Te Velde SJ, Timperio A, Van Lenthe F, Tak NI, Crawford D, Brug J & Oenema A. The association between intentions and sports participation among adolescents is moderated by the availability of sports facilities: A longitudinal study. Submitted for publication

Reports

Other publications


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