Children's Food Environment

Studies on environmental determinants of primary school children's dietary behaviour

Wilke van Ansem

Children's Food Environment

Studies on environmental determinants of primary school children's dietary behaviour

Wilke van Ansem

IVO

Children's Food Environment

Studies on environmental determinants of primary school children's dietary behaviour

Voedingsomgeving van kinderen

Studies naar omgevingsdeterminanten van het voedingsgedrag van basisschoolkinderen

Proefschrift

ter verkrijging van de graad van doctor aan de
Erasmus Universiteit Rotterdam
op gezag van de rector magnificus

Prof.dr. H.A.P. Pols

en volgens besluit van het College voor Promoties.

De openbare verdediging zal plaatsvinden op
vrijdag 17 april 2015 om 11.30 uur

door

Wilhelmina Johanna Carola van Ansem
geboren te Maarheeze

ERASMUS UNIVERSITEIT ROTTERDAM

Promotiecommissie

Promotor
Prof.dr. H. van de Mheen

Overige leden
Prof.dr. S.P.J. Kremers
Prof.dr. H. Raat
Prof.dr. I.H.M. Steenhuis

Copromotor
Dr. F.J. van Lenthe

Voor papa

Voor Mama
I still miss you so,
But I know that you are with me.

Children's Food Environment
Studies on environmental determinants of primary school children's dietary behaviour.
(IVO reeks 74)
Wilke van Ansem

ISBN 978 90 74234 93 1

Financial support for the research presented in this thesis was provided by ZonMw, the Netherlands Organisation for Health Research and Development.

Content

chapter 1

introduction

General introduction

General introduction

1.1 Childhood obesity

The prevalence rates of overweight and obesity in childhood have almost doubled worldwide [1]. Globally, the number of overweight children under the age of five years was reported to be over 42 million in 2011 [2]. The prevalence rates of different countries vary considerably; for example, the prevalence of overweight was the highest in Greece (44.4% of the boys and 37.7% of the girls were overweight), and the lowest in Norway (15.1% of the boys and 13.8% of the girls were overweight) [3]. The same study showed that the prevalence rates of overweight in Norway, Belgium and the Netherlands were significant lower than in the other European countries [3]. Although the prevalence rates of overweight and obesity among Dutch adolescents are lower compared with some European countries [3, 4], they have also increased substantially over the years. Among Dutch boys (aged 2-21 years) the prevalence rate of overweight almost tripled from 5.1% in1980 to 13.3% in 2010, and for Dutch girls these rates increased from 7.2% in 1980 to 14.9% in 2010 [5].

Childhood overweight and obesity tends to track into adulthood with negative health consequences in later life [6]. Hypertension, diabetes mellitus type II, pulmonary disorders, musculoskeletal disorders, cardiovascular disease and some types of cancers are among the long-term negative health outcomes which may be caused by childhood obesity [7-11]. In addition, childhood overweight and obesity causes negative health outcomes which manifest in childhood and/or adolescence including asthma, non-alcoholic fatty liver disease, and adverse psychosocial health effects such as depression and poor self-esteem [11-16]. Given the high and increasing prevalence rates of overweight and obesity, the adverse health consequences and the fact that childhood obesity tracks into adulthood, the prevention of overweight and obesity among children is an important public health issue. However, for effective overweight and obesity prevention it is necessary to identify important modifiable risk factors and to understand their underlying mechanisms and determinants.

Overweight and obesity are caused by a long-term weight gain. This weight gain is the result of an imbalance between energy intake and energy expenditure, in which more calories are consumed than expended by physical activity. The energy balance is thus primarily influenced by dietary behaviour, physical activity and sedentary behaviour (also referred to as energy balance-related behaviour, EBRB). Although the development of overweight and obesity is an interaction between all the EBRBs, this thesis focuses on the determinants and underlying mechanisms of children's dietary behaviour. This introductory chapter provides some background information about the studies presented in the thesis.

1.2 Children's dietary behaviour

Dietary behaviour is not only related to overweight and obesity but also to several chronic diseases such as cardiovascular disease, diabetes mellitus, several types of cancer, and osteoporosis in later life [17]. Some dietary behaviours may reduce the risk of obesity or chronic diseases ('healthy' dietary behaviour), while other dietary behaviours may increase the risk of developing obesity or chronic diseases ('unhealthy' dietary behaviour). Many countries have developed national dietary recommendations to guide the public in how to obtain a health-promoting dietary pattern in order to promote health and reduce the risk of chronic diseases. Below, we elaborate on these 'healthy' and 'unhealthy' dietary behaviours of children in relation to health and dietary recommendations.

Healthy dietary behaviour

One of the healthy dietary behaviours concerns the dietary intake of fruit and vegetables. Fruit and vegetables are low in energy and rich in vitamins, minerals, fibre and antioxidants. Fruit and vegetables have beneficial health effects, e.g. fruit and vegetable consumption in childhood can reduce the risk of respiratory diseases [18-24]. Many countries have dietary recommendation guidelines for fruits and vegetables for children. For example, the World Health Organisation (WHO) and the Food and Agriculture Organization (FAO) of the United Nations recommended a daily intake of 400 grams of both fruits and vegetables [17]. In the Netherlands, the recommendations for fruit and vegetable intake for children are a daily consumption of at least two pieces of fruit and 150 grams of vegetables [25]. Despite the beneficial health effects of fruit and vegetables, the majority of the children in many countries, including the Netherlands, do not consume the recommended amounts of fruit and vegetables [26-28].

Daily breakfast consumption is often considered to be a healthy food habit and it is often mentioned that breakfast is the most important meal of the day. Several studies found an association between breakfast consumption and a well-balanced diet and lower prevalence of overweight [29-31]. In addition, regular breakfast consumption is associated with better cognitive performance among children and adolescents [32]. Although regular breakfast consumption has been labelled a healthy dietary habit and daily breakfast consumption is often recommended, breakfast skipping by children and adolescents is highly prevalent [33-35].

Unhealthy dietary behaviour

The consumption of sugar-sweetened beverages (SSBs) is considered to be one of the least favourable dietary behaviours. SSBs often contain high amounts of added sugars and are, therefore, high in calories. In addition, SSBs are a poor source of nutrients. High consumption of SSBs is associated with overweight and obesity [36]. The consumption of SSBs among children and adolescents in the USA and Europe is high. For example, a US study found that 84% of the adolescents consume SSB on a daily basis, with an average consumption of 887 ml (30 oz) throughout the day, which is equivalent to about 16% of their total energy intake [37]. Among Dutch adolescents a mean intake of more than 450 ml a day has been reported [4]. High consumption of energy-dense snacks (e.g. potato chips, candy bars, cake, chocolates) is also associated with overweight and obesity [36, 38]. These energy-dense snacks are often high in fat and sugars and low in nutrients, and are high caloric. A study in the US reported that children consume almost three energy-dense snacks a day, accounting for up to 27% of the daily caloric intake [39].

Thus, it appears that many children do not show favourable dietary habits and do not meet the dietary recommendations for fruit and vegetables. To prevent chronic diseases and obesity in later life, there is a need to improve dietary behaviour. It is even more important to improve the dietary behaviour of children, as eating habits in childhood track into adulthood [40, 41]. However, in order to improve the dietary behaviour of children more insight is needed into the determinants of dietary behaviour among children.

1.3 Determinants of dietary behaviour in children

For many decades, research on the determinants of dietary behaviour focused on individual factors such as taste preferences, attitude, self-efficacy and nutritional knowledge, without taking into account the environment that shapes this behaviour. However, the trend of increasing obesity in many developed countries cannot be explained by individual determinants alone. Therefore, it has been postulated that the environment may be a driving force for the increasing obesity prevalence; consequently, in recent decades, more attention has been paid to the role of environmental factors in dietary behaviour. Several socio-ecological models and theories have been developed that address the complex interplay between different types and levels of the environment and behaviour [42, 43]. An example of such a model is the Ecological Systems Theory of Bronfenbrenner [44, 45]. According to that theory, our behaviour is influenced by different levels or systems of the environment. The different systems range from the micro system (which refers to the direct environment in which we live and includes the family setting, school setting and neighbourhood setting) to the macro system (which refers to institutional patterns of culture). A key feature of the Ecological Systems Theory is the interaction between the different environmental systems and settings. Furthermore, the theory states that, throughout the human lifespan, different environments are encountered that may influence behaviour to a varying extent.
Swinburn's ANGELO (ANalysis Grid for Environments Linked to Obesity) framework was originally developed to conceptualise the obesogenic environment in order to identify and prioritise environmental elements for obesity [46], but may also be a useful tool for dissecting environmental influences in determinant research [47]. According to the ANGELO framework, the environment can be divided in two environmental levels (the micro and macro level). Individuals interact with the environment in multiple micro-settings such as home, schools and neighbourhood. Micro-environments are influenced by macro-environments such as the educational system, the government and the food industry. Within the subdivision in environmental levels, the ANGELO grid also distinguishes four types of environments; these include the *physical environment* (e.g. availability of foods in home or food stores), the *economic environment* (e.g. the cost of food), the *political environment (*e.g. the family rules or school rules regarding food), and the *socio-cultural environment* (e.g. beliefs related to dietary behaviour).

Environmental influences on children's dietary behaviour

For schoolchildren it is most likely that the micro-environment will mainly influence their dietary behaviour. The home environment, school environment and neighbourhood are the micro-environmental settings which schoolchildren encounter. Of these three environmental settings, determinants of the home environment are the most extensively studied. The home environment is considered to have an important influence on the dietary habits of especially young children [48]. The home environment is a broad concept and includes the home availability and accessibility of food, parental food rules, parenting role modelling, and parenting feeding styles. Several (review) studies found an association between the home availability of foods, parental dietary intake, and parental food rules and children's dietary behaviour [49-56].
Schools are often considered as an ideal setting to promote healthy dietary behaviour, as children spend a significant part of their time there, and often consume food and beverages during school time [57]. A range of studies focused on the implementation and evaluation of school-based interventions to promote healthy dietary habits. These studies showed that multi-component interventions (e.g. a combination of health education, availability of healthy foods and parental involvement) can improve children's dietary behaviour [58, 59]. Furthermore, it was found that school food policies (nutrition guidelines) are positively associated with children's dietary behaviour [60]. Although schools are a promising setting to promote healthy eating habits among children, and the school food policy seems to be an important tool to create a healthy food environment at schools, research on the school food environment and school food policy is scarce.
The role of the neighbourhood environment is increasingly examined in the context of the obesity epidemic [61-63]. Nevertheless, research examining the influence of factors of the neighbourhood on children's dietary behaviour is limited. Moreover, the results of some of these studies are conflicting. For example, it was found that living further away from a supermarket was positively associated with children's fruit and vegetable consumption [64, 65] while another study found no association between the proximity of a supermarket and children's fruit and vegetable consumption [66].

In summary, most research investigating environmental influences on children's dietary behaviour has focused on home environmental factors. Less is known about the influence of the school environment and neighbourhood environment on children's dietary behaviour, while these settings are also part of their direct living environment. According to the Ecological Systems Theory these different environmental settings interact. However, to date few studies have examined the elements of multiple environmental settings on children's dietary behaviour. Therefore, in this thesis we focus on determinants of the home, school and neighbourhood environment and the interaction between these environmental settings.

1.4 Socio-economic inequalities and children's dietary behaviour

It is known that health is not equally divided over the general population and that socio-economic status (SES) can affect health. SES is an individual's or a group's position in social standing relative to the social standing of others [67]. The most commonly used indicators of SES are educational level, occupation and income. People with a low SES generally have a higher mortality rate and their healthy life expectancy at birth is lower than those with a higher SES [68]. Health risk behaviour, such as smoking, poor dietary habits and physical activity, are also more common in lower SES groups than in higher SES groups and also contribute to the development of inequalities in health.
Although most studies on socio-economic inequalities of health and health-related behaviours are performed among adults, some focus on children and adolescents. For example, a Dutch study found that children from families with lower socio-economic backgrounds experience poorer general health, more asthma symptoms and more frequent respiratory infections and were more likely to be obese [69]. Also other studies found that children and adolescents of lower SES groups were more likely to have overweight or obesity [70]. Recently, Statistic Netherlands (CBS) found that 19% of the Dutch children and adolescents (aged 2-25 years) with a low SES had overweight, compared to 11% of the children and adolescents with a high SES. In addition, children and adolescents in the lowest SES group were found to be three times more likely to have obesity than children and adolescents in the highest SES groups [71]. Socio-economic inequalities in children's dietary behaviour were also found, wherein children of lower SES groups showed the least favourable dietary behaviour [72, 73]. For example, children of low SES groups consumed less fruit and vegetables, and consumed more sweets and soft drinks, than their counterparts with a high SES [74-78].
Socio-economic inequalities in health are often perceived to be unfair. Socio-economic health inequalities among children are even more unfair, as their SES is based on their parents' SES. A decrease in socio-economic inequalities would not only be beneficial for those with a low SES, but for the health status of the whole population by reducing the risk of several diseases and the associated costs and burdens. Therefore, reducing socio-economic inequalities in children's dietary behaviour involves both fairness and social justice, and is considered a key priority in public health [79]. As SES does not directly influence dietary behaviour and is not an easily modifiable correlate of children's dietary behaviour, it is important to identify modifiable determinants that may explain the socio-economic inequalities in children's dietary behaviour. However, few studies have examined the mechanisms underlying the socio-economic inequalities in children's dietary behaviour.

1.5 Aim

The aims of this thesis are:
- To investigate modifiable environmental determinants of dietary behaviour of primary school children aged 10-12 years.
- To investigate socio-economic inequalities in dietary behaviour of primary school children aged 10-12 years.
- To investigate whether modifiable environmental factors can explain socio-economic inequalities among primary school children aged 10-12 years.

As stated above, this thesis focuses on determinants of the home, school and neighbourhood environment and the interaction between these environmental settings. The influence of these environmental settings may depend on the age and life stage of the children. For younger children, parents and the home environment may be more important, while for older children the influence of school and peers may be more important.
This thesis focuses on primary school children aged 10-12 years who are in the transition from childhood to adolescence, and who become more autonomous regarding their dietary behaviour. Therefore, we decided to study a broad range of environmental determinants. Figure 1 presents the general research framework used in this thesis and shows the environmental factors investigated.

1.6 INPACT Study

Data of the studies described in this thesis are retrieved from the INPACT study. INPACT is the acronym for IVO Nutrition and Physical Activity Child cohorT. INPACT is a prospective, longitudinal study with a 4-year follow-up (started in the autumn of 2008). The study focuses on modifiable determinants of EBRB and overweight in the home environment, school environment and neighbourhood environment of 8-12 year old children in the Netherlands. Approval for the INPACT study was obtained from the Ethical Committee of the Erasmus MC (University Medical Centre Rotterdam).
INPACT was conducted among primary school children and their parents in the southern part of the Netherlands. All general primary schools in this area were invited to participate in the study by the Municipal Health Authority for Eindhoven and surrounding area (GGD Brabant-Zuidoost). Of the 265 invited schools, 91 primary schools took part. The response rate from urban and rural schools was equal. The primary caregiver of the third-grade children (aged 8 years) were invited to participate in this study together with their child. Of the 2948 parent-child dyads invited, 1840 (62.4%) gave informed consent to participate in the INPACT study.
The study included four annual assessments, in which trained research assistants visited the schools and measured the weight and height of the children, and the parents completed a questionnaire. Besides the demographic characteristics and children's and parents' EBRB, the topics of the questionnaire varied annually. In the first two years the focus of the questionnaire was on measuring the socio-cultural and physical home environment, whereas in the last two years the focus was on the school and neighbourhood environment. In addition to baseline measurements, the children complete a short questionnaire at school under the supervision of trained research assistants. This child questionnaire focused on child-related determinants of EBRB. The studies presented in this thesis are based on parent-and child reported data and measured height and weight from the third and fourth wave of data collection (2010 and 2011).
In addition, a one-time food store audit was conducted in the city of Eindhoven to measure neighbourhood characteristics. Finally, semi-structured interviews with principals and teachers were conducted to collect data on the diet and activity-related school food policy of the primary schools.

1.7 Outline of this thesis

This thesis is divided in two parts. Part one presents a set of studies examining the association between environmental determinants of the home, school and neighbourhood and children's dietary behaviour. **Chapter 2** describes determinants of the home environment and the neighbourhood environment on children's fruit and vegetable consumption. **Chapter 3** focuses on the school food environment and presents the results of a study exploring school food policy at Dutch primary schools. **Chapter 4** investigates the role of parents, peers and children's food purchasing behaviour in relation to children's snack consumption.

The second part of this thesis focuses on socio-economic inequalities in the dietary behaviour of primary school children and investigates whether modifiable environmental factors can explain such inequalities in children's dietary behaviour. **Chapter 5** investigates socio-economic inequalities in children's fruit, vegetable and breakfast consumption and examines whether the home food environment mediates the association between SES and children's healthy eating behaviour. The study in **Chapter 6** examines the association between SES and children's unhealthy eating behaviour (snack consumption and consumption of SSBs) and explores possible environmental factors mediating these associations. **Chapter 7** examines whether the characteristics of the local food environment can explain socio-economic inequalities in children's fruit and vegetable consumption.

Finally, **Chapter 8** provides an overview and discussion of the main findings of the studies presented in this thesis. In addition, methodological considerations are addressed and recommendations are made for future research and practice.

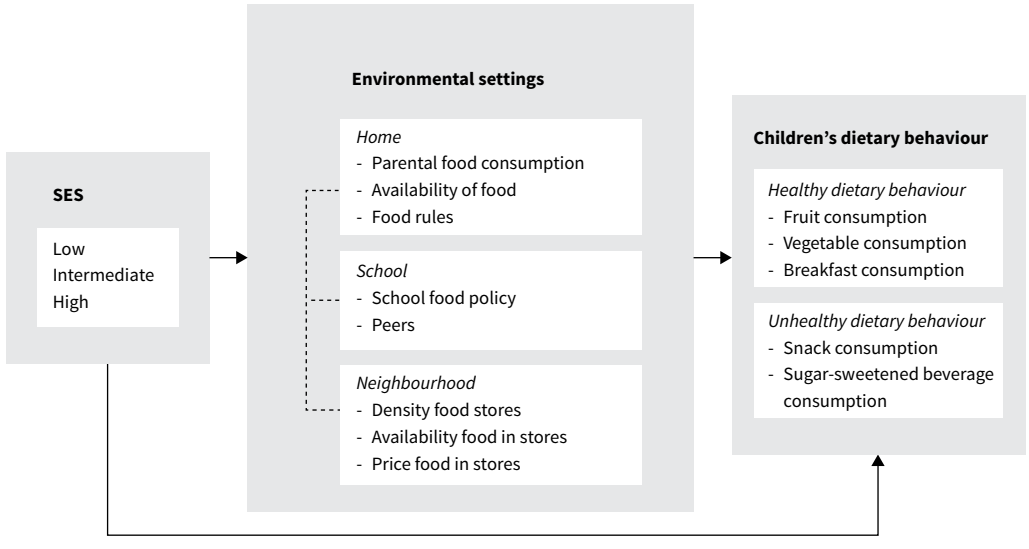

Figure 1 General research framework

References

1. Swinburn BA, Sacks G, Hall KD, Mcpherson K, Finegood DT, Moodie ML, Gortmaker SL: **The global obesity pandemic: shaped by global drivers and local environments**. *Lancet* 2011, **378**:804–814.
2. World Health Organization: *Factsheet No 311, Obesity and Overweight*. 2011.
3. Brug J, van Stralen MM, Te Velde SJ, Chinapaw MJM, De Bourdeaudhuij I, L ien N, Bere E, Maskini V, Singh AS, Maes L, Moreno L, Jan N, Kovacs E, Lobstein T, Manios Y: **Differences in weight status and energy-balance related behaviors among schoolchildren across Europe: the ENERGY-project.** *PLoS One* 2012, **7**:e34742.
4. Brug J, van Stralen MM, Chinapaw MJM, De Bourdeaudhuij I, Lien N, Bere E, Singh AS, Maes L, Moreno L, Jan N, Kovacs E, Lobstein T, Manios Y, Te Velde SJ: **Differences in weight status and energy-balance related behaviours according to ethnic background among adolescents in seven countries in Europe: the ENERGY-project.** *Pediatr Obes* 2012.
5. Schönbeek Y, Van Buuren S: *Factsheet Resultaten Vijfde Landelijke Groeistudie*. 2010.
6. Singh a S, Mulder C, Twisk JWR, van Mechelen W, Chinapaw MJM: **Tracking of childhood overweight into adulthood: a systematic review of the literature.** *Obes Rev* 2008, **9**:474–88.
7. Han JC, Lawlor DA, Kimm SYS: **Childhood obesity.** *Lancet* 2010, **375**:1737–48.
8. Owen CG, Whincup PH, Orfei L, Chou Q-A, Rudnicka AR, Wathern AK, Kaye SJ, Eriksson JG, Osmond C, Cook DG: **Is body mass index before middle age related to coronary heart disease risk in later life? Evidence from observational studies.** *Int J Obes (Lond)* 2009, **33**:866–77.
9. Daniels SR: **Complications of obesity in children and adolescents.** *Int J Obes (Lond)* 2009, **33 Suppl 1**:S60–5.
10. Gilliland FD: **Obesity and the Risk of Newly Diagnosed Asthma in School-age Children**. *Am J Epidemiol* 2003, **158**:406–415.
11. Ebbeling CB, Pawlak DB, Ludwig DS: **Childhood obesity: public-health crisis, common sense cure.** *Lancet* 2002, **360**:473–82.
12. Van Grieken A, Renders CM, Wijtzes AI, Hirasing R a, Raat H: **Overweight, Obesity and Underweight Is Associated with Adverse Psychosocial and Physical Health Outcomes among 7-Year-Old Children: The "Be Active, Eat Right" Study.** *PLoS One* 2013, **8**:e67383.
13. Strauss RS, Background A: **The online version of this article , along with updated information and services , is located on the World Wide Web at : Childhood Obesity and Self-Esteem**. 2000.
14. Erickson SJ, Robinson TN, Haydel KF, Killen JD: **Are Overweight Children Unhappy?** 2000, **154**:931–935.
15. Papoutsakis C, Priftis KN, Drakouli M, Prifti S, Konstantaki E, Chondronikola M, Antonogeorgos G, Matziou V: **Childhood overweight/obesity and asthma: is there a link? A systematic review of recent epidemiologic evidence.** *J Acad Nutr Diet* 2013, **113**:77–105.
16. Pacifico L, Nobili V, Anania C, Verdecchia P, Chiesa C: **Pediatric nonalcoholic fatty liver disease, metabolic syndrome and cardiovascular risk.** *World J Gastroenterol* 2011, **17**:3082–91.
17. *Diet, Nutrition and the Prevention of Chronic Diseases. Joint WHO/FAO Expert Consultation. WHO Technical Report Series*. Geneva; 2003.
18. He FJ, Nowson C a, Lucas M, MacGregor G a: **Increased consumption of fruit and vegetables is related to a reduced risk of coronary heart disease: meta-analysis of cohort studies.** *J Hum Hypertens* 2007, **21**:717–28.

19. Cancer Research Fund/ American Institute for Cancer: *Food, Nutrition, Physical Activity and the Prevention of Cancer: A Global Perspective*. DC:AICR; 2007.
20. Johnsen SP: **Intake of fruit and vegetables and risk of stroke: an overview.** *Curr Opin Clin Nutr Metab Care* 2004, **7**:665–70.
21. Maynard M, Gunnell D, Emmett P, Frankel S, Davey Smith G: **Fruit, vegetables, and antioxidants in childhood and risk of adult cancer: the Boyd Orr cohort.** *J Epidemiol Community Health* 2003, **57**:218–25.
22. Antova T, Pattenden S, Nikiforov B, Leonardi GS, Boeva B, Fletcher T, Rudnai P, Slachtova H, Tabak C, Zlotkowska R, Houthuijs D, Brunekreef B, Holikova J: **Nutrition and respiratory health in children in six Central and Eastern European countries.** *Thorax* 2003, **58**:231–6.
23. Farchi S, Forastiere F, Agabiti N, Corbo G, Pistelli R, Fortes C, Dell'Orco V, Perucci CA: **Dietary factors associated with wheezing and allergic rhinitis in children.** *Eur Respir J* 2003, **22**:772–80.
24. Forastiere F, Pistelli R, Sestini P, Fortes C, Renzoni E, Rusconi F, Dell'Orco V, Ciccone G, Bisanti L: **Consumption of fresh fruit rich in vitamin C and wheezing symptoms in children. SIDRIA Collaborative Group, Italy (Italian Studies on Respiratory Disorders in Children and the Environment).** *Thorax* 2000, **55**:283–8.
25. The Netherlands Nutrition Centre Foundation: *Richtlijnen Voedselkeuze (Dietary Guidelines).* The Hague; 2011.
26. Diethelm K, Jankovic N, Moreno L a, Huybrechts I, De Henauw S, De Vriendt T, González-Gross M, Leclercq C, Gottrand F, Gilbert CC, Dallongeville J, Cuenca-Garcia M, Manios Y, Kafatos A, Plada M, Kersting M: **Food intake of European adolescents in the light of different food-based dietary guidelines: results of the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Study.** *Public Health Nutr* 2012, **15**:386–98.
27. Ocké MC: **Dutch National Food Consumption Survey – Young Children 2005/2006**. *Public Health* 2007.
28. Vereecken C, Huybrechts I, Maes L, De Henauw S: **Food consumption among preschoolers. Does the school make a difference?** *Appetite* 2008, **51**:723–6.
29. Szajewska H, Ruszczynski M: **Systematic review demonstrating that breakfast consumption influences body weight outcomes in children and adolescents in Europe.** *Crit Rev Food Sci Nutr* 2010, **50**:113–9.
30. Timlin MT, Pereira MA, Story M, Neumark-Sztainer D: **Breakfast eating and weight change in a 5-year prospective analysis of adolescents: Project EAT (Eating Among Teens).** *Pediatrics* 2008, **121**:e638–45.
31. Niemeier HM, Raynor HA, Lloyd-Richardson EE, Rogers ML, Wing RR: **Fast food consumption and breakfast skipping: predictors of weight gain from adolescence to adulthood in a nationally representative sample.** *J Adolesc Health* 2006, **39**:842–9.
32. Hoyland A, Dye L, Lawton CL: **A systematic review of the effect of breakfast on the cognitive performance of children and adolescents.** *Nutr Res Rev* 2009, **22**:220–243.
33. Vereecken C, Dupuy M, Rasmussen M, Kelly C, Nansel TR, Al Sabbah H, Baldassari D, Jordan MD, Maes L, Niclasen BV-L, Ahluwalia N: **Breakfast consumption and its socio-demographic and lifestyle correlates in schoolchildren in 41 countries participating in the HBSC study.** *Int J Public Health* 2009, **54 Suppl 2**:180–90.
34. Rampersaud GC, Pereira MA, Girard BL, Adams J, Metzl JD: **Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents.** *J Am Diet Assoc* 2005, **105**:743–60; quiz 761–2.
35. Hallström L, Vereecken C, Ruiz JR, Patterson E, Gilbert CC, Catasta G, Díaz L-E, Gómez-Martínez S, González Gross M, Gottrand F, Hegyi A, Lehoux C, Mouratidou T, Widham K, Aström A, Moreno LA, Sjöström M: **Breakfast habits and factors influencing food choices at breakfast in relation to socio-demographic and family factors among European adolescents. The HELENA Study.** *Appetite* 2011, **56**:649–657.
36. Rennie KL, Johnson L, Jebb SA: **Behavioural determinants of obesity.** *Best Pract Res Clin Endocrinol Metab* 2005, **19**:343–58.
37. Wang YC, Bleich SN, Gortmaker SL: **Increasing caloric contribution from sugar-sweetened beverages and 100% fruit juices among US children and adolescents, 1988-2004.** *Pediatrics* 2008, **121**:e1604–14.
38. Nicklas TA, Yang S-J, Baranowski T, Zakeri I, Berenson G: **Eating patterns and obesity in children**. *Am J Prev Med* 2003, **25**:9–16.
39. Piernas C, Popkin BM: **Trends in snacking among U.S. children.** *Health Aff (Millwood)* 2010, **29**:398–404.
40. Kelder SH, Perry CL, Klepp KI, Lytle LL: **Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors.** *Am J Public Health* 1994, **84**:1121–6.
41. Craigie AM, Lake A a., Kelly S a., Adamson AJ, Mathers JC: **Tracking of obesity-related behaviours from childhood to adulthood: A systematic review.** *Maturitas* 2011, **70**:266–84.
42. Kremers SPJ, de Bruijn G-J, Visscher TLS, van Mechelen W, de Vries NK, Brug J: **Environmental influences on energy balance-related behaviors: a dual-process view.** *Int J Behav Nutr Phys Act* 2006, **3**:9.
43. Glass TA, McAtee MJ: **Behavioral science at the crossroads in public health: extending horizons, envisioning the future.** *Soc Sci Med* 2006, **62**:1650–71.
44. Bronfenbrenner U: **Ecology of the family as a context for human development: Research perspectives.** *Dev Psychol* 1986, **22**:723–744.
45. Bronfenbrenner U: *Making Human Beings Human: Bioecological Perspectives on Human Development*. Thousand Oaks: SAGE Publications; 2005.
46. Swinburn B, Egger G, Raza F: **Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity.** *Prev Med (Baltim)* 1999, **29**(6 Pt 1):563–70.
47. Kremers SPJ: **Theory and practice in the study of influences on energy balance-related behaviors.** *Patient Educ Couns* 2010, **79**:291–8.
48. Lindsay AC, Sussner KM, Kim J, Gortmaker S: **The role of parents in preventing childhood obesity.** *Future Child* 2006, **16**:169–86.
49. Rasmussen M, Krølner R, Klepp K-I, Lytle L, Brug J, Bere E, Due P: **Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies.** *Int J Behav Nutr Phys Act* 2006, **3**:22.
50. Van der Horst K, Oenema a, Ferreira I, Wendel-Vos W, Giskes K, van Lenthe F, Brug J: **A systematic review of environmental correlates of obesity-related dietary behaviors in youth.** *Health Educ Res* 2007, **22**:203–26.
51. Pearson N, Biddle SJH, Gorely T: **Family correlates of breakfast consumption among children and adolescents. A systematic review.** *Appetite* 2009, **52**:1–7.
52. Pearson N, Biddle SJH, Gorely T: **Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review.** *Public Health Nutr* 2009, **12**:267–83.
53. Verzeletti C, Maes L, Santinello M, Vereecken C a: **Soft drink consumption in adolescence: associations with food-related lifestyles and family rules in Belgium Flanders and the Veneto Region of Italy.** *Eur J Public Health* 2010, **20**:312–7.
54. Hendrie G, Sohonpal G, Lange K, Golley R: **Change in the family food environment is associated with positive dietary change in children.** *Int J Behav Nutr Phys Act* 2013, **10**:4.

55. Pearson N, Ball K, Crawford D: **Predictors of changes in adolescents' consumption of fruits, vegetables and energy-dense snacks.** *Br J Nutr* 2011, **105**:795–803.
56. Verloigne M, Van Lippevelde W, Maes L, Brug J, De Bourdeaudhuij I: **Family- and school-based predictors of energy balance-related behaviours in children: a 6-year longitudinal study.** *Public Health Nutr* 2013, **16**:202–11.
57. Story M, Kaphingst KM, French S: **The role of schools in obesity prevention**. *Futur Child* 2006, **16**:109–142.
58. De Bourdeaudhuij I, Van Cauwenberghe E, Spittaels H, Oppert J-M, Rostami C, Brug J, Van Lenthe F, Lobstein T, Maes L: **School-based interventions promoting both physical activity and healthy eating in Europe: a systematic review within the HOPE project.** *Obes Rev* 2011, **12**:205–216.
59. Van Cauwenberghe E, Maes L, Spittaels H, van Lenthe FJ, Brug J, Oppert J-M, De Bourdeaudhuij I: **Effectiveness of school-based interventions in Europe to promote healthy nutrition in children and adolescents: systematic review of published and "grey" literature.** *Br J Nutr* 2010, **103**:781–97.
60. Jaime PC, Lock K: **Do school based food and nutrition policies improve diet and reduce obesity?** *Prev Med (Baltim)* 2009, **48**:45–53.
61. Saelens BE, Sallis JF, Frank LD, Couch SC, Zhou C, Colburn T, Cain KL, Chapman J, Glanz K: **Obesogenic neighborhood environments, child and parent obesity: the Neighborhood Impact on Kids study.** *Am J Prev Med* 2012, **42**:e57–64.
62. Rahman T, Cushing RA, Jackson RJ: **Contributions of built environment to childhood obesity.** *Mt Sinai J Med* 2011, **78**:49–57.
63. Gordon-Larsen P, Nelson MC, Page P, Popkin BM: **Inequality in the built environment underlies key health disparities in physical activity and obesity.** *Pediatrics* 2006, **117**:417–24.
64. Timperio A, Ball K, Roberts R, Campbell K, Andrianopoulos N, Crawford D: **Children's fruit and vegetable intake: associations with the neighbourhood food environment.** *Prev Med (Baltim)* 2008, **46**:331–5.
65. Skidmore P, Welch A, van Sluijs E, Jones A, Harvey I, Harrison F, Griffin S, Cassidy A: **Impact of neighbourhood food environment on food consumption in children aged 9-10 years in the UK SPEEDY (Sport, Physical Activity and Eating behaviour: Environmental Determinants in Young people) study.** *Public Health Nutr* 2010, **13**:1022–30.
66. Ding D, Sallis JF, Norman GJ, Saelens BE, Harris SK, Kerr J, Rosenberg D, Durant N, Glanz K: **Community food environment, home food environment, and fruit and vegetable intake of children and adolescents.** *J Nutr Educ Behav* 2012, **44**:634–8.
67. Galobardes B, Shaw M, Lawlor D a, Lynch JW, Davey Smith G: **Indicators of socioeconomic position (part 1).** *J Epidemiol Community Health* 2006, **60**:7–12.
68. Mackenbach J: *Health Inequalities: Europe in Profile*. 2006.
69. Ruijsbroek A, Wijga AH, Kerkhof M, Koppelman GH, Smit HA: **The development of socio-economic health differences in childhood : results of the Dutch longitudinal PIAMA birth cohort**. *BMC Public Health* 2011, **11**:225.
70. Danielzik S, Czerwinski-Mast M, Langnäse K, Dilba B, Müller MJ: **Parental overweight, socioeconomic status and high birth weight are the major determinants of overweight and obesity in 5-7 y-old children: baseline data of the Kiel Obesity Prevention Study (KOPS).** *Int J Obes Relat Metab Disord* 2004, **28**:1494–502.
71. **Statistics Netherlands** [http://www.cbs.nl/en-GB/menu/themas/gezondheid-welzijn/publicaties/artikelen/archief/2013/2013-3874-wm.htm?Languageswitch=on]
72. Cutler GJ, Flood A, Hannan P, Neumark-Sztainer D: **Multiple sociodemographic and socioenvironmental characteristics are correlated with major patterns of dietary intake in adolescents.** *J Am Diet Assoc* 2011, **111**:230–40.
73. Craig LC a, McNeill G, Macdiarmid JI, Masson LF, Holmes B a: **Dietary patterns of school-age children in Scotland: association with socio-economic indicators, physical activity and obesity.** *Br J Nutr* 2010, **103**:319–34.
74. De Coen V, Vansteelandt S, Maes L, Huybrechts I, De Bourdeaudhuij I, Vereecken C: **Parental socioeconomic status and soft drink consumption of the child. The mediating proportion of parenting practices.** *Appetite* 2012, **59**:76–80.
75. Vereecken C, Keukelier E, Maes L: **Influence of mother's educational level on food parenting practices and food habits of young children.** *Appetite* 2004, **43**:93–103.
76. Bere E, van Lenthe F, Klepp K-I, Brug J: **Why do parents' education level and income affect the amount of fruits and vegetables adolescents eat?** *Eur J Public Health* 2008, **18**:611–5.
77. Hanson MD, Chen E: **Socioeconomic status and health behaviors in adolescence: a review of the literature.** *J Behav Med* 2007, **30**:263–85.
78. Riediger ND, Shooshtari S, Moghadasian MH: **The influence of sociodemographic factors on patterns of fruit and vegetable consumption in Canadian adolescents.** *J Am Diet Assoc* 2007, **107**:1511–8.
79. Marmot Review. *Fair Society, Healthy Lives*. London; 2010.

part one

Environmental determinants of children's dietary behaviour

chapter 2

Is there an association between the home food environment, the local food shopping environment and children's fruit and vegetable intake?

Results from the Dutch INPACT study

Is there an association between the home food environment, the local food shopping environment and children's fruit and vegetable intake?

Results from the Dutch INPACT study

Wilke J.C. van Ansem, Carola T.M. Schrijvers, Gerda Rodenburg, Dike van de Mheen
Public Health Nutrition, 2013 16(7):1206-14

Abstract

Objective: To examine: 1) the association between home availability of fruit and vegetables and children's fruit and vegetables intake; 2) the association between perceptions of the local food shopping environment, and the home availability of fruit and vegetables; and 3) whether the home availability of fruit and vegetables mediated the association between perceptions of the local food environment and children's fruit and vegetable consumption.

Design: Cross-sectional study.

Setting: A total of 91 primary schools in the Netherlands.

Subjects: In total 1501 primary caregivers completed a questionnaire to measure children's fruit and vegetable consumption, home availability of fruit and vegetables, parental perceptions of the local food shopping environment (price, quality and availability), the child's socio-economic status, the child's ethnicity and maternal height and weight.

Results: The home availability of fruit and vegetables was positively associated with children's fruit and vegetable intake ($P<0.01$ and $P<0.001$, respectively). Negative parental perceptions of the local food shopping environment were associated with less fruit available at home ($P<0.05$, $P<0.01$ and $P<0.05$ for price, quality and availability of fruit, respectively). No significant associations were found between parental perceptions of the local food shopping environment and children's fruit and vegetable consumption. We found no evidence that home availability of fruit and vegetables mediates the association between perceptions of the local food environment and children's fruit and vegetable intake.

Conclusion: Interventions focusing on improving the home availability of fruit and vegetables may help to increase children's fruit and vegetable consumption. However, more data are required on factors influencing the home availability of fruit and vegetables.

Introduction

The beneficial effects on health of fruit and vegetables are well documented. Fruit and vegetables are rich in vitamins and fibres and can protect against cardiovascular diseases, some types of cancer and obesity [1–3]. There is also evidence that fruit and vegetable consumption in childhood protects against respiratory diseases [4–6]. It is also reported that fruit consumption in childhood reduces the risk of cancer in adulthood [7]. Because of the beneficial effects of fruit and vegetables many countries (including the Netherlands), have dietary recommendation guidelines for fruit and vegetable intake for adults and children. For example, the USDA (United States Department of Agriculture) recommends children aged 9-13 years old a daily intake of one and a half cup of fruit and two cups of vegetables [8]. The WHO (world health organisation) and Food and Agriculture Organisation (FAO) recommend daily intake of 400 grams of both fruit and vegetables [9]. The Dutch dietary guidelines for children aged 9-13 years recommend to consume at least 2 pieces of fruit and 150 g of vegetables per day [10]. However, the majority of children in the Netherlands, as in many other countries, do not consume these recommended amounts [11–14]. This stresses the need to develop interventions aimed at promoting increased intake of fruit and vegetables among children. In order to develop such interventions, more knowledge on the determinants of their fruit and vegetable intake is required.

Several studies have examined the correlates of children's nutritional behaviour. Traditionally, these focussed on individual-level correlates such as knowledge, attitudes, beliefs and taste preference. In recent years, ecological models and frameworks have highlighted the need to consider environmental factors in relation to nutritional behaviour [15–18]. For children the home food environment, local food shopping environment and the school food environment are important settings in which their nutritional behaviour takes place. Most Research on environmental correlates of children's fruit and vegetable consumption included the home food environment [19–23] and the local food shopping environment [24–26].

The home food environment is a broad concept and includes home availability and accessibility of food, parental role modelling, parenting feeding styles and family food rules. Several literature reviews concluded that elements of the home food environment were associated with children's fruit and vegetable intake. One of the elements of the home food environment that has been strongly associated with children's fruit and vegetable consumption is food availability at home. Children eat more fruit and vegetables when fruit and vegetables are available in their homes [1, 21–23].

The local food shopping environment includes measures of proximity and density of food outlets, availability, and quality and price of food in shops. Research on the association between aspects of the local food shopping environment and children's fruit and vegetable intake is limited [24–26]; most studies in this field were performed among adults. Some studies among children and adolescents have been performed, but with inconsistent findings. For example, one study found that children with more fast food restaurants and convenience stores close to home consumed lower levels of fruit and vegetables; it was also found that children who lived further away from a supermarket or a fast food store consume more vegetables[24]. Another study found that children who lived further away from supermarkets consume more fruit and vegetables; however, this study found that a higher density of supermarkets in a neighbourhood was related to an increased vegetable consumption [25]. In a more recent study, no association was found between the proximity of food outlets and children's fruit and vegetable consumption [26].

As stated before, most research on environmental determinants of children's fruit and vegetable intake mainly focuses on either the home food environment or the local food shopping environment. Few studies have focused on both the home food environment and the local food shopping environment. It is likely that the local food shopping environment influences the home food environment, especially the home availability of fruit and vegetables. Therefore, the main aim of this study is to examine both direct and indirect pathways between the local food shopping environment and children's fruit and vegetable intake (Figure 1; conceptual research model).

The local food shopping environment can be measured objectively (e.g. objective assessment via geographic information systems) or subjectively (e.g. perceptions about characteristics of the local food shopping environment). Objectively measured environmental determinants neglect the perception of respondents about their environments. This perception is likely to be more important for behavioural choices, such as fruit and vegetable consumption than objectively measured aspects of the local food shopping environment [27]. This study is, as far as we known, the first one which examines subjectively measured factors of the local food shopping environment in relation to children's fruit and vegetable consumption.

In this paper, we examine: 1) the association between home availability of fruit and vegetables and children's fruit and vegetables intake; 2) the association between perceptions of the local food shopping environment, and the home availability of fruit and vegetables; and 3) whether the home availability of fruit and vegetables mediates the association between perceptions of the local food shopping environment and children's fruit and vegetables intake.

Methods

Population and design

INPACT is the acronym for IVO Nutrition Physical Activity Child cohorT. INPACT is a longitudinal Dutch study among 8-12 year old children and their parents. The aim of the study is to examine environmental determinants of children's dietary behaviour and physical activity. In 2008 the INPACT study started among third-grade children (age ± 8 years); the subsequent waves of data collection took place in 2009 (second wave) and 2010 (third wave).

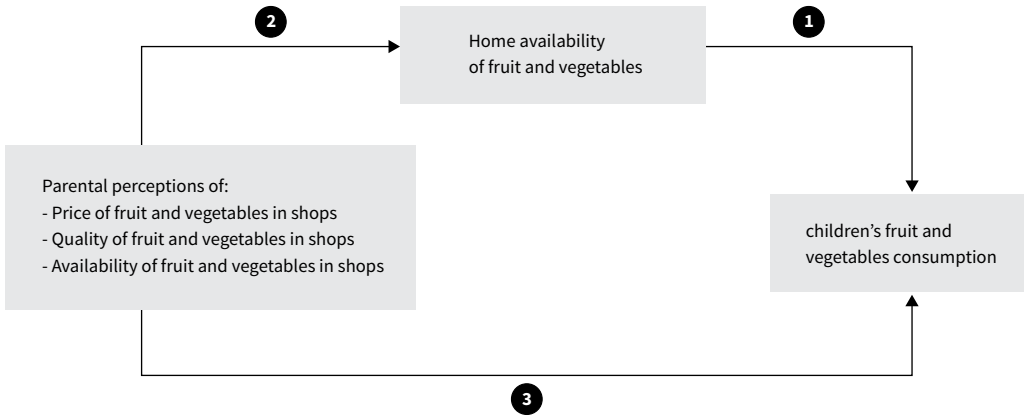

Figure 1 Conceptual research model

Participants were recruited through primary schools in the southern part of the Netherlands (Eindhoven and surroundings). All general primary schools (n=265) in this area were invited to participate in this study by the municipal health services; finally, 91 schools (34·3%) took part in this study. The response rate from rural and urban schools was equal. A sample of 1,844 primary caregivers and their children (62·5%) gave informed consent. The INPACT study was approved by the Ethical Committee of Erasmus Medical Centre Rotterdam.

The present study was based on the data collection of the third wave (2010) of the INPACT study, which is the only wave that collected data on the local food shopping environment. All data presented in this study were measured by means of a questionnaire. The primary caregiver filled in a questionnaire at home; 1,501 (81·4%) primary caregivers, of which 91,1% (N=1378) were the biological mother, completed the questionnaire in 2010.

Measures

Fruit and vegetable intake

Usual fruit and vegetable intake was measured with a questionnaire that was based on validated Food Frequency Questionnaires [28, 29]. The primary care giver of the child was asked how often his/her child usually eats: 1) fruit (fresh or canned fruit), 2) cooked, fried, steamed or otherwise heated vegetables, 3) salad or other raw vegetables. Answering categories ranged from "none or less than one day a week" to "7 days a week". The primary caregiver was also asked how many servings of fruit and vegetables their child usually eats. For fruit, answering categories ranged from: '0 pieces a day' to, 'more than 3 pieces a day', by increments of half a piece of fruit. Reported fruit consumption of more than 3 pieces a day (n=12) was recoded as 4 pieces a day. For vegetables, answer categories ranged from '0 serving spoons' to 'more than 4 serving spoons a day', by increments of half a serving spoon. Reported vegetable consumption of more than 4 serving spoons (n=22) was recoded as 5 serving spoons. One serving spoon was equivalent to 50 grams of vegetables, which is a standard serve of vegetables in the Netherlands. Total fruit and vegetable intake was calculated for each child by multiplying consumption frequency and serving portions. Total fruit and vegetable intake was dichotomised to be consistent with the current Dutch guidelines for fruit (< 2 pieces a day/ ≥2 pieces a day) and vegetables (<150 g/per day/ ≥150 g/per day) for children in this age group.

Home availability fruit and vegetables

The availability of fruit and vegetables at home was measured with a questionnaire based on the validated Home Environment Survey [30]. The primary caregiver was asked about the availability of fruit and vegetables in their home, separately. Response categories were "yes, always", "yes, usually", "sometimes", "no, usually not" and "no, never". Due to limited variability of these variables we dichotomised both variables into "always" (yes, always) and "not always" ("yes, usually"; "sometimes"; "no, usually not" and "no, never).

Local food shopping environment

We measured perceptions of the local food shopping environment with regard to: 1) price of fruit and vegetables 2) quality of fruit and vegetables and 3) availability of fruit and vegetables in the shops. Parental perceptions of these features were measured with three statements ("Fruit is expensive"; "Quality of fruit is bad"; and "Availability of fruit in the shops is limited"). For vegetables the same statements were used. Answering categories for these statements were dichotomous: "agree" or "disagree". The statements about the local food shopping environment have been used in another Dutch study [31] and were based on the results from a focus group of Dutch adults [32] and a literature review, to identify salient environmental determinants of fruit and vegetable consumption.

To avoid misunderstanding about the meaning of 'the local food shopping environment', we described in the questionnaire that the above mentioned statements refer explicitly to food shopping outlets where participants usually go to purchase their fruit or vegetables.

Potential confounders

Child age, child ethnicity, socioeconomic status of the child and body mass index (BMI) of child and mother were assessed as potential confounders.

Children's age was calculated from date of birth and date of measurement. Child's ethnicity was categorized into native Dutch (both parents were born in the Netherlands), Western immigrants (at least one of the parents was not born in the Netherlands, but inside Europe (including former Yugoslavia and Soviet Union, North America, Oceania, Indonesia or Japan) or non-Western immigrants (at least one of the parents was born in Turkey, Africa, Latin America or Asia).

Maternal educational level was used to measure the socioeconomic status (SES) of the child. Maternal educational level was categorized into three groups; low educational level (primary school and lower secondary education), intermediate educational level (intermediate vocational education, higher secondary school and pre-university education) or high educational level (higher vocational education and university).

Body mass index

Children's weight and height were measured in underwear without shoes to the nearest 0·1 cm and 0·1 kg; the measurements were made by trained research assistants. Weight and height were used to calculate the children's body mass index (BMI); subsequently, children's BMI was categorized as "underweight", "normal weight" and "overweight/obese" [33]. Overweight and obesity were pooled into one category due to small numbers of obese children. Maternal BMI was calculated from self-reported data of weight and height. Maternal BMI was categorized into underweight (BMI < 18·5), normal weight (BMI 18·5-24·99) and overweight or obesity (BMI > 25).

Statistical analyses

Descriptive analyses were performed to describe the distribution of child age, child gender, child ethnicity, child BMI, maternal BMI and maternal educational level, child consumption of fruit and vegetables, home availability of fruit and vegetables, and parental perceptions of the local food environment.

Pearson Chi-square test was used to explore possible confounders (child age, child gender, child ethnicity, child BMI, maternal BMI, maternal educational level). Based on the results of the Pearson Chi-square test, all analyses were controlled for ethnicity, child BMI and maternal education level.

We used the four step approach of Baron and Kenny to test whether home availability of fruit and vegetables mediated the association between the local food shopping environment and children's fruit and vegetable consumption [34]. According to Baron and Kenny a mediator has to be associated with the predicted variable and with the outcome variable, and the predicted variable has to be associated with the outcome variable (step 1-3 of the approach). When the associations in step 1-3 are all significant, the criteria for mediation are met. Subsequently, step 4 assesses whether it is full mediation or partial mediation. To test if the criteria for mediation were met, several multivariate logistic regression models were computed to assess the associations between (Fig. 1):

1) home availability of fruit and vegetables (possible mediator) and children's fruit and vegetables consumption (outcome variable).
2) parental perceptions of local food shopping environment (predicted variable) and home availability of fruit and vegetables (possible mediator).
3) parental perception of local food shopping environment (predicted variable) and fruit and vegetables consumption (outcome variable).

All analyses were performed with the statistical software package IBM SPSS statistics 19. Due to missing values the numbers of participants included in the analyses differs for each model that was computed.

Results

Participant's characteristics

Table 1 presents some characteristics of the study population. Mean age of the children was 10·2 years, most were native Dutch (86·0%), and 15.2% were overweight or obese. The majority of the mothers had an intermediate level of educational, and 33·0% of them were overweight or obese.

Table 1 Characteristic of the study population

Characteristics		N	%
Age	9 years	45	3·0
	10 years	1172	78·4
	11 years	268	17·9
	> 12 years	9	0·6
Gender	Boys	757	50·5
	Girls	742	49·5
Ethnicity	Dutch	1288	86·0
	Western	121	8·1
	Non-western	89	5·9
Child's BMI	Underweight	116	7·0
	Normal weight	1281	77·7
	Overweight/obese	251	15·2
Mother's BMI	Underweight	19	1·3
	Normal weight	953	65·7
	Overweight/obese	479	33·0
Mother's education level	Low	380	22·1
	Intermediate	791	46·1
	High	545	31·8

Associations between home availability of fruit and vegetables and children's fruit and vegetable consumption

Most children did not consume the recommended amount of fruit and vegetables: 87·4% of the children consumed < 2 pieces of fruit per day and 83·8% consumed < 150 g of vegetables per day.

The majority of the children had fruit (88·8%) or vegetables (80·8%) always available in their homes.

Table 2 shows the association between the home availability of fruit and vegetables and children's fruit and vegetables consumption. Children who lived in a household where fruit was not always available were less likely to consume the recommended amount of fruit (OR and 95% CI: 4·08, 1·75, 9·48).

For vegetables, a similar association was found between home availability and children's consumption (OR and 95%: 2·62 1·61, 4·26).

Table 2 Association between home availability of fruit and vegetables and children's fruit and vegetable consumption.

	% children not consuming recommended amount of fruit or vegetables	OR	95% CI
Home availability of Fruit † (n=1323)*			
Always available	86·3%	1.00	
Not always available	96·4%	4·08††	1·75, 9·48
Home availability of vegetables† (n= 1314)*			
Always available	81·9%	1.00	
Not always available	92·3%	2·62†††	1·61, 4·26

* Analyses adjusted for child's ethnicity, child's body mass index (BMI) and child's socio-economic status
† Home availability of fruit and vegetables was measured on a 5 point scale which was dichotomised into "always available" (yes, always) and "not always available" ("yes, usually"; "sometimes"; "no, usually not" and "no, never). †† P< 0·01, ††† P< 0·001

Associations between parental perceptions of the local food shopping environment and home availability of fruit and vegetables

Table 3 provides data on parental perception of the local food environment. A minority of parents had a negative perception about the price of fruit or vegetables (fruit: 16·0%, vegetables: 11·5%), quality of fruit or vegetables (fruit: 4·4%, vegetables: 3·0%), and the availability of fruit or vegetables in shops (fruit: 4·0%, vegetables: 4·3%). Table 4 presents data on the association between parental perception about the price, quality and availability of fruit and vegetables in shops, and the home availability of fruit and vegetables. Children of parents with a negative perception of price, quality and availability were more likely to not always have fruit available in their homes (Price OR and 95% CI 1·56 1·02, 2·40; Quality OR and 95% CI 3·03 1·59, 5·77; Availability OR and 95% CI 2·79 1·38, 5·64). For vegetables, no significant association was found between parental perception concerning the price, quality and availability in shops and the availability of vegetables at home.

Table 3 Negative parental perceptions of price, quality and availability of fruit and vegetables in shops.

Negative parental perceptions of the local food shopping environment		n	%
Price (n=1465)	Fruit is expensive	234	16·0
Quality (n=1469)	Quality of fruit is bad	65	4·4
Availability (n=1466)	Availability of fruit in shops is bad	58	4·0
Price (n=1465)	Vegetables are expensive	168	11·5
Quality (n=1465)	Quality of vegetables is bad	44	3·0
Availability (n=1468)	Availability of vegetables in shops is bad	63	4·3

Table 4 Association between parental perception of price, quality and availability of fruit and vegetables and the availability of fruit and vegetables at home.

	% children that do not always have fruit or vegetables available at home†	OR	95% CI
Fruit*			
Price (N=1303)			
Fruit is expensive	15	1·56††	1·02,2·40
Fruit is not expensive	10·5	1·00	
Quality (N=1309)			
Quality of fruit in shops is bad	23·4	3·03†††	1·59, 5·77
Quality of fruit in shop is not bad	10·5	1·00	
Availability (N1306)			
Availability of fruit in shops is limited	20·7	2·79††	1·38, 5·64
Availability of fruit in shops is not limited	10·9	1·00	
Vegetables*			
Price (N=1294)			
Vegetables are expensive	17·4	0·93	0·60,1·44
Vegetables are not expensive	19·8	1.00	
Quality (N=1295)			
Quality of vegetables in shops is bad	22·7	1·34	0·65, 2·79
Quality of vegetables in shops is not bad	19·3	1.00	
Availability (N=1298)			
Availability of vegetables in shops is limited	23·0	1·63	0·89, 3·09
Availability of vegetables in shops is not limited	19·2	1.00	

* Analyses adjusted for child's ethnicity, child's body mass index (BMI) and child's socio-economic status
† Home availability of fruit and vegetables was measured on a 5 point scale which was dichotomised into "always available" (yes, always) and "not always available" ("yes, usually"; "sometimes"; "no, usually not" and "no, never). †† P <0·05, ††† P < 0·01

Associations between parental perceptions of the local food shopping environment and children's fruit and vegetable consumption

Table 5 presents data on the association between parental perception of the price, quality and availability of fruit and vegetables in shops, and children's fruit and vegetable consumption. None of the aspects of local food shopping environment was associated with children's fruit and vegetable consumption.

Table 5 Association between parental perception of price, quality and availability of fruit and vegetables and children's fruit and vegetables consumption.

	% children not consuming the recommended amount of fruit or vegetables	OR	95% CI
Fruit*			
Price (N=1300)			
Fruit is expensive	87·1	0·89	0·57, 1·40
Fruit is not expensive	87·7	1·00	
Quality (N=1306)			
Quality of fruit in shops is bad	89·2	0·67	0·26,1·72
Quality of fruit in shop is not bad	87·5	1·00	
Availability (N=1303)			
Availability of fruit in shops is limited	89·7	0·36	0·11, 1·20
Availability of fruit in shops is not limited	87·4	1·00	
Vegetables*			
Price (N=1299)			
Vegetables are expensive	83·3	1·01	0·64, 1·59
Vegetables are not expensive	83·8	1.00	
Quality (N=1301)			
Quality of vegetables in shops is bad	90·9	0·54	0·19, 1·56
Quality of vegetables in shops is not bad	83·5	1.00	
Availability (N=1304)			
Availability of vegetables in shops is limited	82·5	0·77	0·79, 1·67
Availability of vegetables in shops is not limited	83·7	1.00	

* Analyses adjusted for child's ethnicity, child's body mass index (BMI) and child's socio-economic position

Mediation of the home food environment on the local food shopping environment and children's fruit and vegetable consumption

We found no association between parental perceptions of the local food shopping environment and children's fruit and vegetable consumption, and no association between parental perceptions of the local food shopping environment and the home availability of vegetables. Therefore, the criteria for mediation were not met for both the association between the local food shopping environment and children's fruit consumption and the association between the local food shopping environment and children's vegetable consumption.

Discussion

This study is one of the first to examine associations between perception of the local food shopping environment, home food environment and children's fruit and vegetable intake. It was found that children, who lived in a household where fruit and/or vegetables were not always available, were less likely to consume the recommended daily amount of fruit or vegetables. Furthermore, negative parental perceptions of the local food shopping environment were associated with a reduced availability of fruit at home. No associations were found between parental perceptions of the local food shopping environment and children's fruit and vegetable intake. Finally, home availability of fruit and vegetables did not mediate the association between parental perceptions of the local food shopping environment and children's fruit and vegetable consumption.

The finding that home availability of fruit and vegetables is positively associated with children's fruit and vegetable consumption is in line with earlier studies [35–37]. Several reviews have concluded that home availability of fruit and vegetables is an important aspect of the home environment in relation with children's fruit and vegetable intake [21–23].

However, before developing interventions targeting home availability of fruit and vegetables, more knowledge on factors influencing the availability of fruit and vegetables is needed. Few studies have examined determinants of the home availability of fruit and vegetables. The present study investigates the relationship between parental perceptions of the local food shopping environment and home availability of fruit and vegetables. Our results show that negative perceptions of price, quality and availability of fruit in shops are associated with less fruit being available at home, albeit the associations are weak. Contrary to our expectations we found no associations between parental perceptions of price, quality and availability of vegetables in shops and the home availability of vegetables. However, because only a very small number of people agreed with the statements about the local food shopping environments, there was insufficient variation of the independent variables. This might explain why we found only a weak association between parental perceptions of the local food shopping environment and the home availability of fruit and no association between parental perceptions of the local food shopping environment and the home food environment of vegetables. Another explanation for the different findings between parental perceptions of the local food shopping environment and fruit and vegetable availability at home, may be Dutch dietary habits. Traditionally, Dutch people consume three main meals per day and a snack between the main meals. Vegetables are a part of the dinner (as is fish or meat, and rice or pasta), whereas fruit is not generally a part of the main meals. In the Netherlands, fruit is mainly consumed as a kind of snack and is generally seen as 'something extra'. Therefore the purchase of vegetables may not be influenced by perceptions about price, quality and availability, whereas this may be the case for fruit. The present study examined associations between parental perception about the local food shopping environment and children's fruit and vegetable consumption. For both fruit and vegetables no such association was found. This is unexpected because an association was found between parental perceptions and the home availability of fruit (Fig. 1; association 2), and a strong association was found between the home availability of fruit and children's fruit consumption (Fig. 1; association 1). This unexpected finding may be due to insufficient variation in either the dependent or the independent variable to detect any association.

To get more variation in the data we performed the analyses with fruit- and vegetable consumption as a continuous variable; however, these analyses yielded comparable results (data not shown). Unfortunately, it was not possible to increase the variability of the measures of the local food shopping environment because the perceptions were measured on a dichotomous scale.
Besides possible methodological shortcomings of the present study another explanation may be that parental perceptions of the local food shopping environment are too distal to directly influence child behaviour. Other determinants such as preference of food taste, food habits or parental attitude regarding fruit and vegetables, may be in the indirect pathway and could be more important in relation to children's fruit and vegetable consumption. Also, other factors acting like mediators (which we did not measured) may have an opposite effect than the direct effect of parental perceptions of the local food shopping environment and children's fruit and vegetable consumption. The opposite effect of the direct pathway and the indirect pathway can cancel each other out, resulting in a non-significant overall relationship between parental perceptions of the local food shopping environment and children's fruit and vegetable consumption.
To our knowledge, no other studies have examined the relation between children's fruit and vegetable intake and subjectively measured environmental determinants. However, studies among adults have examined the perceived local food shopping environment and fruit and vegetable consumption. One Dutch study found that some of the subjectively measured factors of the local food shopping neighbourhood were associated with fruit and vegetable consumption; their finding that the quality and availability of fruit and vegetables in shops was not significantly associated with participants' fruit and vegetable consumption is in line with our results [31]. Another study found that perceived greater access to fruit and vegetables was significantly associated with increased fruit and vegetable intake, while two other American studies found no significant association between subjectively measured determinants of the local food shopping environment and participants' fruit and vegetable consumption [38, 39]. However, their results are difficult to compare with ours due to different measures of the local food shopping environment. Furthermore, the urban landscape in the Netherlands differs from that in the USA. The population density in the Netherlands is high and shops are generally close to participants' homes. Due to these differences in landscaping the results of the USA studies may be not generalizable to the Netherlands.
The present study has some limitations which may have influenced the results. Firstly, our study has a cross-sectional design, which hampers drawing conclusions about any causal relationships. Secondly, only one third of the schools and 62.5% of the parents participated in this study. However, the school response rate among urban and rural areas was equal. Furthermore, the consumption of fruit and vegetables and the overweight and obesity prevalence were comparable to national prevalence rates among children [40]. Therefore, we think that the results in our study are not biased through selective participation.
A third limitation is the use of parent reports on children's fruit and vegetable consumption instead of child reports. It is still unclear however, whether child reports or parents report in child fruit consumption are more valid. Two Dutch studies reported low agreement between parent and child report on child fruit and vegetable intake [41, 42]. However, a Dutch study concluded that parents report could be considered as a valid method to measure children's fruit and vegetable intake [41]. Nevertheless, parents may respond in a socially desirable way, i.e. they may overestimate home availability of fruit and vegetable and overestimate their children's fruit and vegetable consumption. However, we do not expect that this has significantly influenced our results.
Finally, we used maternal educational level as a measure of SES of the household, instead of household income, due to the high number of missing values on this variable (31·2 %). Several studies emphasize that cost is one of the most important determinants of consumer's food choice [43, 44]. Therefore, household income may be a more appropriate measure of the SES of the household. However, after performing all analyses again with household income as measure for SES (data not shown), the direction and magnitude of the results were similar to those reported based on maternal educational level.
In conclusion, in the present study, only 12·6% of the children met the recommendation for fruit consumption and only 16·2% met the recommendation for vegetable consumption. The home availability of fruit and vegetables was strongly associated with children's fruit and vegetable intake. Weaker associations were found for subjectively measured factors of the local food shopping environment and the availability of fruit at home. Interventions focusing on improving the home availability of fruit and vegetables may contribute to an increase of children's fruit and vegetable consumption. However, more knowledge on the factors influencing the home availability of fruit and vegetables is required.

References

1. He FJ, Nowson C a, Lucas M, MacGregor G a: **Increased consumption of fruit and vegetables is related to a reduced risk of coronary heart disease: meta-analysis of cohort studies.** *J Hum Hypertens* 2007, **21**:717–28.
2. Johnsen SP: **Intake of fruit and vegetables and risk of stroke: an overview.** *Curr Opin Clin Nutr Metab Care* 2004, **7**:665–70.
3. Cancer Research Fund/ American Institute for Cancer: *Food, Nutrition, Physical Activity and the Prevention of Cancer: A Global Perspective*. DC:AICR; 2007.
4. Antova T, Pattenden S, Nikiforov B, Leonardi GS, Boeva B, Fletcher T, Rudnai P, Slachtova H, Tabak C, Zlotkowska R, Houthuijs D, Brunekreef B, Holikova J: **Nutrition and respiratory health in children in six Central and Eastern European countries.** *Thorax* 2003, **58**:231–6.
5. Farchi S, Forastiere F, Agabiti N, Corbo G, Pistelli R, Fortes C, Dell'Orco V, Perucci CA: **Dietary factors associated with wheezing and allergic rhinitis in children.** *Eur Respir J* 2003, **22**:772–80.
6. Forastiere F, Pistelli R, Sestini P, Fortes C, Renzoni E, Rusconi F, Dell'Orco V, Ciccone G, Bisanti L: **Consumption of fresh fruit rich in vitamin C and wheezing symptoms in children. SIDRIA Collaborative Group, Italy (Italian Studies on Respiratory Disorders in Children and the Environment).** *Thorax* 2000, **55**:283–8.
7. Maynard M, Gunnell D, Emmett P, Frankel S, Davey Smith G: **Fruit, vegetables, and antioxidants in childhood and risk of adult cancer: the Boyd Orr cohort.** *J Epidemiol Community Health* 2003, **57**:218–25.
8. *Dietary Guidelines for American*. Washington D.C.; 2010.
9. *Diet, Nutrition and the Prevention of Chronic Diseases. Joint WHO/FAO Expert Consultation. WHO Technical Report Series*. Geneva; 2003.
10. The Netherlands Nutrition Centre Foundation: *Richtlijnen Voedselkeuze (Dietary Guidelines).* The Hague; 2011.
11. Diethelm K, Jankovic N, Moreno L a, Huybrechts I, De Henauw S, De Vriendt T, González-Gross M, Leclercq C, Gottrand F, Gilbert CC, Dallongeville J, Cuenca-Garcia M, Manios Y, Kafatos A, Plada M, Kersting M: **Food intake of European adolescents in the light of different food-based dietary guidelines: results of the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Study.** *Public Health Nutr* 2012, **15**:386–98.
12. Huybrechts I, Matthys C, Vereecken C, Maes L, Temme EH, Van Oyen H, De Backer G, De Henauw S: **Food Intakes by Preschool Children in Flanders Compared with Dietary Guidelines**. *Int J Environ Res Public Health* 2008, **5**:243–257.
13. Ocké MC: **Dutch National Food Consumption Survey – Young Children 2005 / 2006**. *Public Health* 2007.
14. Currie C, Roberts C, Morgan A, Smith R, Settertobulte W, Samdal O: **Young people ' s health in context**. *Health Policy (New York)* 2002.
15. Bronfenbrenner u: **Ecology of the family as a context for human development: Research perspectives.** *Dev Psychol* 1986, **22**:723–744.
16. Bronfenbrenner u: *The Ecology of Human Developmental Processes.* 1988:993–1027.
17. Kremers SPJ, de Bruijn G-J, Visscher TLS, van Mechelen W, de Vries NK, Brug J: **Environmental influences on energy balance-related behaviors: a dual-process view.** *Int J Behav Nutr Phys Act* 2006, **3**:9.
18. Swinburn B, Egger G, Raza F: **Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity.** *Prev Med (Baltim)* 1999, **29**(6 Pt 1):563–70.
19. Zive MM, Frank-Spohrer GC, Sallis JF, McKenzie TL, Elder JP, Berry CC, Broyles SL, Nader PR: **Determinants of dietary intake in a sample of white and Mexican-American children.** *J Am Diet Assoc* 1998, **98**:1282–9.
20. Spurrier NJ, Magarey A a, Golley R, Curnow F, Sawyer MG: **Relationships between the home environment and physical activity and dietary patterns of preschool children: a cross-sectional study.** *Int J Behav Nutr Phys Act* 2008, **5**:31.
21. Pearson N, Biddle SJH, Gorely T: **Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review.** *Public Health Nutr* 2009, **12**:267–83.
22. Rasmussen M, Krølner R, Klepp K-I, Lytle L, Brug J, Bere E, Due P: **Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies.** *Int J Behav Nutr Phys Act* 2006, **3**:22.
23. Van der Horst K, Oenema a, Ferreira I, Wendel-Vos W, Giskes K, van Lenthe F, Brug J: **A systematic review of environmental correlates of obesity-related dietary behaviors in youth.** *Health Educ Res* 2007, **22**:203–26.
24. Timperio A, Ball K, Roberts R, Campbell K, Andrianopoulos N, Crawford D: **Children's fruit and vegetable intake: associations with the neighbourhood food environment.** *Prev Med (Baltim)* 2008, **46**:331–5.
25. Skidmore P, Welch A, van Sluijs E, Jones A, Harvey I, Harrison F, Griffin S, Cassidy A: **Impact of neighbourhood food environment on food consumption in children aged 9-10 years in the UK SPEEDY (Sport, Physical Activity and Eating behaviour: Environmental Determinants in Young people) study.** *Public Health Nutr* 2010, **13**:1022–30.
26. Ding D, Sallis JF, Norman GJ, Saelens BE, Harris SK, Kerr J, Rosenberg D, Durant N, Glanz K: **Community food environment, home food environment, and fruit and vegetable intake of children and adolescents.** *J Nutr Educ Behav* , **44**:634–8.
27. Brug J, Kremers SP, Lenthe F Van, Ball K, Crawford D, Boechorststraat V Der, Amsterdam BT: **Environmental determinants of healthy eating: in need of theory and evidence.** *Proc Nutr Soc* 2008, **67**:307–16.
28. Bogers RP, Van Assema P, Kester ADM, Westerterp KR, Dagnelie PC: **Reproducibility, validity, and responsiveness to change of a short questionnaire for measuring fruit and vegetable intake.** *Am J Epidemiol* 2004, **159**:900–9.
29. Haraldsdóttir J, Thórsdóttir I, de Almeida MDV, Maes L, Pérez Rodrigo C, Elmadfa I, Frost Andersen L: **Validity and reproducibility of a precoded questionnaire to assess fruit and vegetable intake in European 11- to 12-year-old schoolchildren.** *Ann Nutr Metab* 2005, **49**:221–7.
30. Gattshall ML, Shoup JA, Marshall JA, Crane LA, Estabrooks PA: **Validation of a survey instrument to assess home environments for physical activity and healthy eating in overweight children.** *Int J Behav Nutr Phys Act* 2008, **5**:3.
31. Giskes K, van Lenthe FJ, Kamphuis CBM, Huisman M, Brug J, Mackenbach JP: **Household and food shopping environments: do they play a role in socioeconomic inequalities in fruit and vegetable consumption? A multilevel study among Dutch adults.** *J Epidemiol Community Health* 2009, **63**:113–20.
32. Kamphuis CBM, van Lenthe FJ, Giskes K, Brug J, Mackenbach JP: **Perceived environmental determinants of physical activity and fruit and vegetable consumption among high and low socioeconomic groups in the Netherlands.** *Health Place* 2007, **13**:493–503.
33. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH: **Establishing a standard definition for child overweight and obesity worldwide: international survey.** *BMJ* 2000, **320**:1240–3.
34. Baron RM, Kenny DA: **The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations.** *J Pers Soc Psychol* 1986, **51**:1173–82.

35. Kristjansdottir AG, Thorsdottir I, Bourdeaudhuij I De, Due P, Wind M, Klepp K: **Determinants of fruit and vegetable intake among 11-year-old schoolchildren in a country of traditionally low fruit and vegetable consumption**. *Int J Behav Nutr Phys Act* 2006, **9**:1–9.
36. Wind M, de Bourdeaudhuij I, te Velde SJ, Sandvik C, Due P, Klepp K-I, Brug J: **Correlates of fruit and vegetable consumption among 11-year-old Belgian-Flemish and Dutch schoolchildren.** *J Nutr Educ Behav* 2006, **38**:211–221.
37. Reinaerts E, de Nooijer J, Candel M, de Vries N: **Explaining school children's fruit and vegetable consumption: the contributions of availability, accessibility, exposure, parental consumption and habit in addition to psychosocial factors.** *Appetite* 2007, **48**:248–58.
38. Caldwell EM, Miller Kobayashi M, DuBow WM, Wytinck SM: **Perceived access to fruits and vegetables associated with increased consumption.** *Public Health Nutr* 2009, **12**:1743–50.
39. Lucan SC, Mitra N: **Perceptions of the food environment are associated with fast-food (not fruit-and-vegetable) consumption: findings from multi-level models.** *Int J Public Health* 2012, **57**:599–608.
40. Schönbeek Y, Van Buuren S: *Factsheet Resultaten Vijfde Landelijke Groeistudie*. 2010.
41. Tak NI, te Velde SJ, de Vries JHM, Brug J: **Parent and child reports of fruit and vegetable intakes and related family environmental factors show low levels of agreement.** *J Hum Nutr Diet* 2006, **19**:275–285.
42. Reinaerts E, de Nooijer J, de Vries NK: **Parental versus child reporting of fruit and vegetable consumption.** *Int J Behav Nutr Phys Act* 2007, **4**:33.
43. Steenhuis IH, Waterlander WE, de Mul A: **Consumer food choices: the role of price and pricing strategies.** *Public Health Nutr* 2011, **14**:1–7.
44. Waterlander WE, de Mul A, Schuit AJ, Seidell JC, Steenhuis IH: **Perceptions on the use of pricing strategies to stimulate healthy eating among residents of deprived neighbourhoods: a focus group study.** *Int J Behav Nutr Phys Act* 2010, **7**:44.

chapter 3

improvement

School food policy at Dutch primary schools: room for improvement?

Cross-sectional findings from the INPACT study

School food policy at Dutch primary schools: room for improvement?

Cross-sectional findings from the INPACT study

Wilke J.C. van Ansem, Carola T.M. Schrijvers, Gerda Rodenburg, Jantine J. Schuijt, Dike van de Mheen
BMC Public Health, 2013, 13:339

Abstract

Background: Schools can play an important role in the prevention of obesity, e.g. by providing an environment that stimulates healthy eating habits and by developing a food policy to provide such an environment. The effectiveness of a school food policy is affected by the content of the policy, its implementation and its support by parents, teachers and principals. The aim of this study is to detect opportunities to improve the school food policy and/or implementation at Dutch primary schools. Therefore, this study explores the school food policy and investigates school's (teachers and principals) and parents' opinion on the school food policy.

Methods: Data on the school's perspective of the food policy was collected at the organisational level (principals) and the executive level (teachers) by means of semi-structured interviews. In total 74 principals and 72 teachers from 83 Dutch primary schools were interviewed. Data on parental perceptions about the school food policy were based on a cross-sectional survey among 1.429 parents from the same schools.

Results: Most principals (87.1%) reported that their school had a written food policy; however in most cases the rules were not clearly defined. Most of the principals (87.8%) believed that their school paid sufficient attention to nutrition and health. Teachers and principals felt that parents were primarily responsible to encourage healthy eating habits among children, while 49.8% of the parents believed that it is also a responsibility of the school to foster healthy eating habits among children. Most parents reported that they appreciated the school food policy and comply with the food rules. Parents' opinion on the enforcement of the school food policy varied; 28.1% believed that the school should more strongly enforce the policy, 32.1% was satisfied, and 39.8 % had no opinion on this topic.

Conclusion: Dutch primary schools could play a more important role in fostering healthy eating habits among children. The school food policy could be improved by: clearly formulating food rules, simplifying supervision of the food rules, and defining how to enforce the food rules. In addition, the school food policy will only influence children's dietary behaviour if both the school and the parents support the policy.

Introduction

Childhood obesity is a major public health concern in many countries [1, 2]. Globally, in 2010 more than 40 million children aged ≤ 5 years were overweight [3]. In the Netherlands, obesity is also a health concern; not necessarily because the prevalence rates are high (they are lower compared with some other European countries[4, 5]), but mainly because the prevalence rates of overweight among Dutch children and adolescents has increased over the years. Among Dutch boys (aged 2-21 years) the prevalence rate of overweight almost tripled from 5.1% in 1980 to 13.3% in 2010, and for Dutch girls these rates increased from 7.2% in 1980 to 14.9% in 2010[6]. Overweight and obesity are related to a range of both short and long term negative health outcomes such as hypertension, diabetes mellitus type II, pulmonary disorders and cardiovascular disease [7–10]. Furthermore, childhood obesity tracks into adulthood[11]. One of the main causes of obesity is unhealthy dietary behaviour, such as high consumption of sugar-sweetened beverages, large portion sizes of food, and meal skipping[12]. Eating habits established in childhood also track into later life[13, 14]. Therefore, it is important to study the determinants of eating habits of children and develop interventions and policies to establish healthy dietary habits at an early stage.

Parents have a strong influence on children's dietary behaviour and the development of their eating habits [15–17]. For example, parents determine the availability and accessibility of food at home, set rules and regulations concerning food consumption and they act as role models.

The school is also considered an important place for the prevention of childhood obesity as children spend a significant part of their time there and often consume food and drinks during school time [18]. Moreover, the staff of schools can potentially reach both children and parents, and schools can be environments that stimulate healthy eating habits.[19] A school food policy could be the basis of such a healthy eating environment. School food policy is a broad concept and includes nutrition guidelines (e.g. nutrition standards for menu planning), regulation of the availability of food and beverages at schools (e.g. types of food sold in the school canteen or vending machines), food rules (e.g. rules about the types of food children are allowed to consume during school time), and price interventions regarding food and beverages sold in school canteens (subsidised provision of specific foods or control of the price of foods and beverages for sale to children). Several studies examined the effectiveness of a school food policy. For example, Jaime and colleagues reviewed the effectiveness of school food policies in the USA and Europe (focusing on nutritional guidelines, regulation of food and beverages availability and price interventions) on: - improving the school food environment, - children's dietary intake and -decreasing overweight/obesity of children. In that review, most evidence for effectiveness was found for the impact of nutritional guidelines; i.e. 8 out of 9 studies showed positive changes in decreasing fat intake and increasing fruit and vegetable availability at school[20]. A Belgium-Flanders study examined the influence of the school food policy (availability of food items, food rules, nutrition education program) on the consumption of fruit, soft drinks, crisps and sweets at primary and secondary schools. The study showed that only at secondary schools did the school food policy have an impact on adolescents' consumption of soft drinks, crisps and sweets [21]. Moreover, it was found that school-based interventions can improve dietary behaviour of children. For example, Van Cauwenberghe and colleagues reviewed school-based interventions across Europe and found strong evidence that multi-component interventions that combine improved availability of fruit and vegetables with a nutrition education curriculum delivered by the teacher and at least some parental involvement can improve children's fruit and vegetable consumption[22]. De Bourdeaudhuij and colleagues reviewed school-based interventions that combined nutrition and physical activity approaches among children and adolescent's in Europe and concluded that multi-component interventions might be preferable in school-based nutrition and physical activity interventions to reduce obesity in European children and adolescents[23].

The Dutch school system is different from school systems in other countries, both in general and regarding food policy. In the Netherlands, compulsory education starts at age of 5 years, but in practice most children start school at age of 4 years. Children aged 4-12 years attend primary school (some primary schools differentiate between infant school and junior school). In the Netherlands, schools are autonomous regarding fostering a healthy food environment and there is no legal obligation to implement a school health promotion program or food policy. Because almost no primary schools offer school meals, Dutch primary schools play a smaller role in fostering healthy eating habits among children than in countries where schools offer cooked meals during the lunch breaks. On the other hand, many Dutch primary schools implement school food rules (e.g. 'children are not allowed to drink sugar-sweetened beverages during school time) and have some kind of food policy.

As stated before, schools are considered as important settings to promote healthy eating habits among children and a school food policy can be an important tool to create healthy eating environments at school. Although a range of studies has focussed on the development and evaluation of school-based interventions[22–24], only few studies explored the food environment and school food policies at primary schools[20, 21] while such knowledge is required to improve the school food environment. The effectiveness of school food policies depends on the content of the policy, and the way it is implemented. Furthermore, the support of teachers, principals and parents is essential for the policy to work, as all are stakeholders in childhood obesity prevention. Insight in the perspectives of the school (teachers and principals) of the parents regarding the school food policy can provide valuable knowledge that can be used to improve the policy.

The overall aim of this study is to explore opportunities to improve the policy and/or implementation of the school food policy in the Netherlands. Therefore, we describe the presence, content and implementation of the school food policy (e.g. communication, enforcement and compliance with the policy). Furthermore, this study explores school's (teachers and principals) and parents' opinion on the school food policy (including appreciation of the policy and the role that schools play in fostering healthy eating habits among children).

School food environment of Dutch primary schools

Before we continue with the description of our study methods, we elaborate on the school food environment of Dutch primary schools. In the Netherlands, children bring their own food to school. Children have two breaks during a school day; a short break in the mid-morning and a lunch break.

For both breaks, children have to bring their own packed foods and beverages. During the morning break, it is normal for children to consume a small snack and/or beverages. During the lunch break, children either go home for lunch or they bring a packed lunch to school and remain at school. In the Netherlands it is not common to consume a cooked meal during lunch break, most people have sandwiches and dairy drinks, coffee or tea.

At Dutch primary schools, no vending machines or canteens are available. Furthermore, children are not allowed to leave the school premises during school time (as stated before children are allowed to go home for lunch, however children who remain at school during lunch break are not allowed to go to shops or cafes during the lunch break) . Classroom celebrations of a child's birthday are common at Dutch primary schools: on such an occasion a child treats his/her classmates with e.g. fruit, cake or sweets and/ or with a small gift.

Methods

We studied a broad range of aspects related to school food policy, such as the content of the policy, communication about the policy with children and parents, compliance with the policy by parents and children, enforcement of the policy by the school, and appreciation of the policy by parents. In addition, we studied the attention schools paid to the subject 'nutrition and health' in their curriculum, and the opinion of teachers, principals and parents regarding the role that schools play in the encouragement of healthy eating habits among children. In this study, school food policy mainly refers to food rules or recommendations (e.g. 'children are not allowed to drink sugar-sweetened beverages during school time), which reflect the food environment at primary schools in the Netherlands.

Study design

Data for this study were collected as part of the INPACT-study (IVO Nutrition and Physical Activity Child cohorT), a longitudinal study on children's nutritional behaviour and physical activity. INPACT started in 2008 among 8-year-old children and their parents. Data collection took place annually; the last wave of the study took place in 2011. Participants were recruited through primary schools in the southern parts of the Netherlands. In this area, all general primary schools (n=265) were invited by the Municipal Health Services, and 91 (34.3%) primary schools agreed to participate. In total 1844 (62.5%) primary caregivers gave informed consent. The INPACT study, including the procedure for informed consent, was approved by the Medical Ethical Committee of the Erasmus Medical Centre Rotterdam.

A mixed-method approach for data collection and analyses was used. Data on the schools' perspective on school food policy were collected by means of semi-structured interviews with principals and teachers. Data on parental perspective of the school food policy were collected by means of a questionnaire.

Interviews

Semi-structured face-to-face interviews were conducted with principals and teachers in the autumn of 2010 (third wave of the INPACT study). Of each participating school in the INPACT study, we approached one principal and one teacher (fifth grade) to participate in the interviews, after they had given consent an appointment for the interview was made. We decided to interview fifth-grade teachers, because the participating children of the third wave of the INPACT study were in the fifth-grade. Six trained interviewers visited the schools and conducted the interviews using a structured topic list (Table 1). The interview with the principal focused on the food rules, communication about food rules with children and parents, attention paid to nutrition, and health by the school. The interviews with the teachers focused on the topics concerning compliance with the school food rules by parents and children, enforcement of the school food rules, and appreciation of the school food rules by parents.

Parental questionnaire

Data among parents were collected in the fourth wave of the INPACT-study (autumn 2011); 1429 (77.5%) primary caregivers completed a self-administered questionnaire at home. The questionnaire coved the following items: school food rules; compliance school food rules, appreciation of the school food rules, enforcement of school food rules, and parents opinion about the role the school plays in the encouragement of healthy eating habits among children. For a detailed description of the items see table 3.

Analysis

Of each interview a detailed summary was made using the interview transcripts and audio-tapes. The detailed summary was organised according to the interview schedule. Data were analysed manually. Statements were coded by two researchers separately (GR and WVA). If the researchers coded statements differently, the interpretation was discussed until consensus was reached. Categorical responses were counted. Descriptive statistics were used to examine parental perceptions about the school food policy.

Results

A total of 72 teachers and 74 principals from 83 primary schools were interviewed. Most teachers were female (63.9%) and most principals were male (64.9%). The majority (92.1%) of the parental questionnaires was completed by the mother.

Table 1 Overview of the interview topics

Topic	Principals	Teachers
School food rules	– Does the school have rules about the food and beverages children are allowed to consume during school time? – Can you describe these food rules?	
Communication about food rules	– Are the food rules written down? – Where are these food rules written down? – Do you inform parents about the food rules? – How do you inform parents about the food rules?	
Compliance with food rules		– Does is frequently happen that children bring food to schools which is not allowed?
Enforcement of food rules		– What do you do when children bring food to school which is not allowed according to the food policy?
Appreciation of food rules		– Do you think that parents appreciate the school food rules? – Why do think that parents appreciate the school food policy?
Attention paid to school food policy and nutrition education	– Does the school pay attention to nutrition and health during class? – Which method or program does the school use to educate children about nutrition and/or health? – In your opinion, does the school pay enough attention to nutrition and health?	
Schools' role in encouragement healthy eating habits children	– Do you believe that encouraging healthy food habits among children is a responsibility of the schools? – What is the role of the parents in encouragement of healthy eating habits among children?	– Do you believe that encouraging healthy food habits among children is a responsibility of the schools? – What is the role of the parents in encouragement of healthy eating habits among children?

School food policy

The majority of the principals reported to have a food policy, meaning that their school had food rules or recommendation about the food and/or beverages children were allowed to consume during school time. More than half of the principals (57.1%) reported that their school had food rules; 37.1% of the principals reported that their school had recommendations and 5.7% of the principals reported that their school had no food policy (Table 2). The most frequently mentioned specific rules or recommendations referred to the following subjects: 1) fruit and vegetables; 2) biscuits; 3) candy; 4) drinks, and 5) the amount of food and drinks children consumed. The rules or recommendations were in most cases unclearly defined. Especially the rules on biscuits were vaguely defined, as the most frequently mentioned definition of the rule on biscuits was: '*only healthy biscuits'/'no unhealthy biscuits'*. Furthermore, principals found it difficult to determine which foods are considered as healthy and which types of food are not. Some principals reported that their school had different rules or recommendations for younger children (age 4-6 years) and older children (age 7-12 years). For example, for younger children it was more often obligatory to eat fruit during morning breaks than for the older children. The above mentioned rules or recommendations were only applicable to the morning break and lunch break. Concerning birthday celebrations, only five principals reported that their school had rules about the type of treats for these occasions. Most schools recommended 'healthy' treats, but this was not a rule.

Parents were asked if the school had food rules for morning breaks, lunch breaks and classroom celebrations. The majority of the parents reported that the school of their child had rules about the food and drinks children were allowed to consume during the morning break (78.2%). Furthermore, 44.9% of the parents reported that the school had rules about birthday celebrations and 42.8% reported that the school had rules about the food and drinks children were allowed to consume during lunch break (Table 3).

Communication about school food policy

Most schools (89.1%) had a written food policy. Schools also undertook activities to inform and remind parents about the school food policy. Most frequently mentioned were "reminder in school magazine" and "reminder in informal meetings". The informal meetings with parents usually took place in the beginning of the school year. In some schools (n=6; 17.1%) these informal meetings were only for parents of children at infant schools (aged 4-6 years) (Table 2).

Table 2 Schools' perspective about aspects of the school food policy

	Principals		Teachers	
	N	%	N	%
School food policy (n=70)				
Rules	40	57.1		
Recommendations	26	37.1		
No food policy	4	5.7		
Written food policy (n=64)				
Yes	57	89.1		
no	7	10.9		
Activities undertaken to inform parents about food policy (n=62)*				
School magazine	46	74.2		
Informal meetings	35	56.5		
Parent's evening	5	8.1		
Parent's council	2	3.2		
Interview on admission to school	7	11.3		
Compliance with school food policy (n=57)				
Yes			45	78.9
Varying			5	8.7
No			7	12.2

Maintenance of school food policy (n=62)*				
Addressing child			19	30.6
Addressing parent			8	12.9
Addressing both parent and child			27	43,.5
Addressing in classroom			6	9.7
Child not allowed to consume the unhealthy food			8	12.9
No set approach			6	9.7
Parental appreciation of school food policy (n=62)				
Good			54	87.1
Varying			7	11.2
Poor			1	1.6
Attention for nutrition by the school (n=74)				
Insufficient	6	8.1		
Sufficient	65	87.8		
No opinion	3	4.1		
Role of the school in fostering healthy eating habits among children (principals n=73; teachers n=72)				
Parents primarily responsible, school supportive role	54	74.0	64	88.9
School and parents equally responsible	12	16.4	4	5.6
School no responsibility	7	9.5	4	5.6

* Multiple answers possible

Compliance with school food policy

Most teachers (78.9 %) reported a good compliance of parents with the school food policy, meaning that most parents and children abided by the food rules/recommendations (Table 2). However, it was mentioned that monitoring compliance with the school food policy was difficult because children often eat their snacks while playing outside in the school playground.

The majority of parents reported that they comply with the school food rules with respect to the morning break (81.8%), birthday celebration (72.5%) and lunch break (88.6%). The most frequently mentioned reason why parents did not comply with the food rules for the morning and lunch break food/beverages was *"nothing else available at home"*. In the case of birthday celebration, the most frequently mentioned reason for breaking the rule was "*preference of the child for another birthday celebration*" (Table 3).

Table 3 Parents 'perspective about aspects of the school food policy

	N	%
School food rules		
"Has the school of your child rules about the food and drinks children are allowed to consume during…"		
Morning break		
Yes	1108	78.2
No	216	15.3
Unknown	92	6.5
Birthday celebration		
Yes	631	44.9
No	620	44.1
Unknown	155	11.0
Lunch break		
Yes	606	42.8
No	431	30.5
Unknown	378	26.7
Compliance with school food rules *		
"Do you comply with the food rules?"		
Morning break		
Always	905	81.8
Not always	202	18.2
Birthday celebration		
Always	453	72.5
Not always	172	27.5
Lunch break		
Always	531	88.6
Not always	68	11.4

Reasons for non-compliance with school food rules**		
"Why do you not always comply with the school food rules?"		
Morning break		
Nothing else available at home	78	37.9
Almost no-one sticks to food rules	11	5.4
Child takes his/her own snack	36	17.5
Not always aware of rules	20	9.7
Disagree with rules	16	7.8
Other reason	45	21.8
Birthday celebration		
Almost no-one sticks to food rules	42	22.7
Not always aware of rules	14	7.6
Disagree with rules	19	10.3
Wishes child	70	37.8
Other reason	40	21.6
Lunch break		
Nothing else available at home	17	25.0
Almost no-one sticks to food rules	4	5.9
Child takes his/her own snack	6	8.8
Not always aware of rules	11	16.1
Disagree with rules	14	20.6
Other reason	16	23.5
Enforcement of school food rules***		
"I believe that the my child's school should more strongly enforce the food rules for morning breaks and classroom celebrations"		
Agree	325	28.1
No opinion	460	39.8
Disagree	371	32.1
Appreciation of food rules***		
"I appreciate that my child's school has food rules about the food children are allowed to eat during morning breaks"		
Agree	943	76.5
No opinion	230	18.7
Disagree	59	4.8
"I appreciate that my child's school has food rules about the food children are allowed to offer during classroom celebrations"		
Agree	618	60.0
No opinion	336	32.6
Disagree	76	7.4
Role of the school in fostering healthy eating habits among children ***		
"It is a responsibility of the school to foster healthy eating habits among children"		
Agree	696	49.8
No opinion	454	32.5
Disagree	247	17.5

* Answering categories ranged from "yes, always" to "no, never" on a 5-point scale. For the purpose of analysis the variables were classified into "always" ('yes, always) versus "not always" ('yes, usually', 'no, usually not', 'sometimes' and 'no, never'). ** Multiple answers possible. ***Answering categories ranged from "completely agree" to "completely disagree" on a 5-point scale. For the purpose of analysis the variables were classified into "agree" ('completely agree' and 'agree'); "no opinion" and "disagree ('disagree' and 'completely disagree').

Enforcement of school food policy

It is not clear how often the school food policy was enforced. Difficulties in enforcement of the food policy mentioned by the teachers include unclearly defined food rules and difficulties in supervision. The most frequently mentioned approaches to enforce the food rules were "addressing/ speaking to the child" and "addressing/ speaking to both parents and child" in the case of lack of compliance with the rules by the child (Table 2).

Some parents were divided in their opinion about the enforcement of the school food rules regarding celebration treats and morning break snacks. The majority of parents (39.8%) had no opinion about the enforcement of the food rules, while others (28.1%) believed that the school food policy should be more strongly enforced, and 32.1% was satisfied with the enforcement of school food rules (Table 3).

Appreciation of school food policy

Most teachers (87.1%) believed that most parents appreciate the school food policy (Table 2). The most frequently mentioned reasons why they thought that parents are satisfied with the food policy were "receive no complaints from parents", "good compliance with the food rules" and "receive positive responses to the food rules".

Most of the parents reported that they appreciated the school food rules regarding the morning breaks (76.5%) and birthday celebrations (60.0%). Nevertheless, 32.6% of the parents had no opinion about whether or not they appreciate that the school had food rules regarding birthday celebrations (Table 3).

Attention paid to school food policy and nutrition education

Almost all schools educated children about nutrition. Only three principals reported that their school did not educate children on this topic. Education on nutrition was part of the school curriculum in the vast majority of the schools (reported by 85.1% of the principals). Nutrition education was embedded in educational topics like biology, physics or lifestyle. Also, 68.9% of the principals reported that their school participates in specific nutrition projects.

The majority of the principals (87.8%) believed that their school paid sufficient attention to nutrition and a healthy lifestyle. Nevertheless, several principals felt that the attention for nutrition and a healthy lifestyle could be improved (table 2). Time was mentioned as a limiting factor to increase focus on this subject. Some principals argued that the socio-economic status of the school population influences the amount of attention the school paid to nutrition and a healthy lifestyle. According to these principals, schools in less deprived areas or schools with more highly educated parents paid less attention to nutrition and healthy lifestyle. The rationale given for this was that higher educated parents were more healthy-minded and had more knowledge about healthy eating behaviours and lifestyle and therefore the school could pay less attention to this subject.

School's role in encouragement healthy eating habits among children

The vast majority of both teachers (88.9%) and principals (74.0%) felt that the parents were primarily responsible to encourage healthy eating habits among children, with schools having a supportive role. In addition, 16.4% of the principals reported that in their opinion schools and parents are equally responsible to foster healthy eating habits among children (Table 2).

About half of the parents (49.8%) believed that encouraging healthy eating habits among children is also a responsibility of the school, 32.4% had no opinion about this topic, and 17.7% of the parents did not believe that the school should play a role in fostering healthy eating habits among children (Table 3).

Discussion

This study investigated the schools' and parents' perspective about the school food policy in Dutch primary schools. The study shows that most primary schools paid attention to nutrition and health. Most schools had a written food policy and informed parents about the food rules. Furthermore, in most schools education on nutrition was part of the school curriculum and most schools participated in specific nutrition projects. In general, parents appreciated the school food rules. Most principals believed that they had only a supportive role to foster healthy eating behaviour among children and considered parents to be primarily responsible. About half of the parents believed that schools should play a role in encouraging healthy food habits among children.

Only few studies have examined schools' or parents' view on the school food policy. For example, a USA study among teachers and parents of middle-school students found that both parents and teachers were concerned about the school food environment and believed schools should offer students more healthful food and beverages and limit low-nutrient food products [25]. However, the results of that study are not comparable with ours, since the school food environment at Dutch primary schools is very different (e.g. at Dutch primary schools no school meals are offered). A European study also found that parents and teachers considered the school food policy to be important, and the majority agrees that there should be a school policy restricting consumptions of snacks and soft drinks [26].

The majority of the principals reported that their school had a food policy; 57.1% reported to have food rules and 37.1% of the principals reported that their school had recommendations about the food and/or beverages children were allowed to consume during school time. Surprisingly, even more parents (78.2%) reported that the school of their child had rules about the food and beverages children were allowed to consume during the morning break. An explanation for the differences in reported school food rules by principals and parent could be that in the semi-structured interviews a distinction was made between "rules" and "recommendations", while the parent questionnaire did not. Perhaps, parents reported that the school of their child had food rules, while the school actually had recommendations. Another notable difference regards the reported food rules for the food morning break and for the lunch break by parents. Of the parents, 72.8% reported that their child's school had rules about the food and drinks that could be consumed during the morning break, but only 42.8% of the parents reported food rules for the lunch break. An explanation for this may be that a part of the parents is not aware of rules about the food and drinks that could be consumed during lunch break, because their child goes home for lunch.

However, it is a positive sign that the majority of the primary schools in our study sample had a written food policy and informed parents about the policy. However, having a food policy does not ensure monitoring and compliance with the policy. The content of the policy, implementation, communication, enforcement and support of stakeholders are important factors that influence the effectiveness of a policy. Our results showed that the food rules were not always clearly formulated. Some schools argued that they had food rules while other schools referred to 'recommendations'. In daily practice, however, there was little difference between so-called rules or recommendations about food and beverages. However, due to the vaguely formulated food rules, enforcement of these rules is difficult. Well formulated rules provide clarity and help to ensure their enforcement. In addition, most schools had no clear approach of how to deal with children who brought food to school that was not allowed in school. In most cases the approach depended on the supervising teacher. Furthermore, supervision was difficult because children often eat their snacks while playing outside.

It is remarkable that most schools did not have food rules regarding birthday celebrations. Several USA studies reported that classroom celebration treats consist of low-nutrient calorie-dense snacks [27]. For example, the mean calorie intake during classroom celebrations for first-grade school children was estimated at 550±212 calories [28]. Also, in the Netherlands, most birthday celebration treats are low-nutrient calorie-dense snacks such as potato chips, candy bars and cake [29]. Because on average there are ± 20-30 children in a classroom, a classroom celebration occurs regularly. Some principals stated that children at an infant school (children aged 4-7 years) sometimes offered fruit as birthday celebration, however older children (junior school) rarely chose fruit for a birthday celebration. A possible explanation for this difference may be peer pressure: i.e. fruit or healthy snacks do not have a 'cool' image. However, birthday celebrations are a tradition at primary schools in the Netherlands and schools apparently have difficulty in adopting a restrictive policy regarding treats offered in birthday celebrations. A restrictive policy may be a promising way to provide a more healthy school food environment, because birthday celebration treats are mostly low in nutrient and high in calories, and such foods are also provided during other occasions at school, such as sports events, Christmas, and other holiday celebrations).

Also notable is the difference between infant and junior schools: some principals mentioned that at infant school it was more obligatory for children to eat fruit during morning breaks. Also there was more supervision regarding the foods and beverages children bring to school (most younger children eat their morning break snack in the classroom). Some of the schools organised meetings to inform parents about school issues including the food policy, these meetings were only for parents of children at infant school and not for parents of children at junior school. An explanation for these differences may be that schools expect children and parents in junior schools to be more familiar with the food policy and thus better comply with the food rules during the rest of their stay at school. However, schools could be more active and structured in bringing the food policy to the attention of parents and children, especially in junior school where peer pressure may increase.

The majority of both principals and teachers believed that parents are primarily responsible for the acquisition of healthy eating habits in children and that schools play a supportive role in fostering children's healthy eating habits. However, schools should consider themselves fully responsible to encourage healthy eating habits among children during school time. Dutch primary schools could be more involved in fostering healthy dietary behaviour among children by offering school meals, as often occurs in the UK and other countries; however, in the Dutch culture this may be difficult to implement. In addition to the school, parents can also take their responsibility in fostering healthy eating habits among their children; for example by supporting the school food policy.

Besides schools and parents, the government can also play a role in encouraging school food policies and healthy eating environments at schools. Governments encourage schools to make school food policy, to provide programmes to stimulate healthy foods, set nutritional standards for the foods that are available at schools or provide national lunch programmes. For example, national distribution schemes which provide free fruit and vegetables to children at schools have been implemented in the UK and USA [30, 31]. Several years ago, the Australian government has recommended that all primary schools implement a fruit and vegetable program (Crunch&Sip) that provides a time in the class that children consumed fruit and vegetables they brought from home [32]. Also in the Netherlands, there are some programs, such as Schoolgruiten (which is an initiative of the Dutch government in cooperation with others), which is a program to stimulate children to eat fruit or vegetables during the morning break [33]. Governments can provide and support initiatives to improve the school food policy and environment; however the success of such initiatives depends on the adaptation and implementation of all relevant stakeholders including the school staff and parents.

Strengths and limitations

A major strength of this study was the use of data from multiple sources. We collected data on the school's perspective at the organizational level and the executive level as well as data on the parental perspective. Furthermore, the sample was substantial; we interviewed 74 principals and 72 teachers from 83 schools and 1.429 parents completed the parental questionnaire.

A limitation of this study is that not all data were collected in the same year. Data of parents were collected one year after the interviews with the principals and teachers took place. It is possible that the school food policy had changed during that year, but we believe that this is unlikely. Data from the teachers/principals and the data from the parents were collected from the same schools, but not compared at school level due to the low numbers of respondents per school. Another limitation is that this study does not provide insight into whether the school food policy actual improves the dietary behaviour of children at school. Although, this study identifies some opportunities to improve school food policy, future research should examine the influence of various aspects of school food policy on children's actual dietary behaviour. Nevertheless, this study provides some valuable knowledge about schools' and parents' opinion on school food policy at Dutch primary schools. A final limitation is that the response rate of schools participating in the INPACT study was 34.1% (n = 91). The most frequently given reason for not participating in the INPACT study was a busy curriculum with a focus on the attainment targets (language skills and arithmetic/maths) of primary schools set by the government. The response rate of urban and rural schools was the same. Furthermore, the sample of schools in the INPACT study reflects the variety of schools in the Dutch primary school system and contains religious schools, public schools and schools based on various educational movements (e.g. Steiner Waldorf education or Montessori schools). A rather low school response rate may impact the generalizability of the results. However, we have no reason to believe that the non-response among schools had an important effect on our results because their refusal was not connected with the subject of the presented study (at the time of recruitment for the INPACT study this sub-study had not yet been designed). Furthermore, 91.3% of the participating schools in the INPACT study took part in the interviews which is a high response rate. Moreover, 77.5% of the parents participate in this study.

Conclusion

This study investigated schools' and parents' perspective of the school food environment to detect opportunities to improve the school food policy. Most primary schools in this study had a school food policy and parents generally appreciated the school food rules. However improvement is possible: schools should formulate clear rules about which foods and beverages may be consumed during school time. Since teachers and principals may find it difficult to determine which food products are healthy and which are not, we recommend schools to cooperate with nutrition experts (e.g. dieticians, or The Netherlands Nutrition Centre Foundation). Within the food policy, special attention should be paid to birthday celebrations. In addition, supervision of the food and beverages that children bring to school can be simplified if children have to consume their foods and/or beverages inside the classroom instead while playing outside. Furthermore, schools should also clearly define how the school food policy will be enforced and the policy should be enforced by the entire school staff, rather than relying on teacher-dependent enforcement.

Finally, school food policy will only have an impact on children's dietary behaviour if it is fully embraced by both the school and the parents. Dutch primary schools could play a more a significant role in fostering healthy dietary behaviour among children. However, teachers and principals, as well as parents, should take more responsibility in encouraging healthy eating habits among children and should fully support a school food policy.

References

1. Kosti RI, Panagiotakos DB: **The epidemic of obesity in children and adolescents in the world.** *Cent Eur J Public Health* 2006, **14**:151–9.
2. Wang Y, Lobstein T: **Worldwide trends in childhood overweight and obesity**. *Int J Pediatr Obes* 2006, **1**:11–25.
3. World Health Organization: *Factsheet No 311, Obesity and Overweight*. 2011.
4. Brug J, van Stralen MM, Te Velde SJ, Chinapaw MJM, De Bourdeaudhuij I, Lien N, Bere E, Maskini V, Singh AS, Maes L, Moreno L, Jan N, Kovacs E, Lobstein T, Manios Y: **Differences in weight status and energy-balance related behaviors among schoolchildren across Europe: the ENERGY-project.** *PLoS One* 2012, **7**:e34742.
5. Brug J, van Stralen MM, Chinapaw MJM, De Bourdeaudhuij I, Lien N, Bere E, Singh AS, Maes L, Moreno L, Jan N, Kovacs E, Lobstein T, Manios Y, Te Velde SJ: **Differences in weight status and energy-balance related behaviours according to ethnic background among adolescents in seven countries in Europe: the ENERGY-project.** *Pediatr Obes* 2012.
6. Schönbeek Y, Van Buuren S: *Factsheet Resultaten Vijfde Landelijke Groeistudie*. 2010.
7. Han JC, Lawlor DA, Kimm SYS: **Childhood obesity.** *Lancet* 2010, **375**:1737–48.
8. Daniels SR: **Complications of obesity in children and adolescents.** *Int J Obes (Lond)* 2009, **33 Suppl 1**:S60–5.
9. Gilliland FD: **Obesity and the Risk of Newly Diagnosed Asthma in School-age Children**. *Am J Epidemiol* 2003, **158**:406–415.
10. Owen CG, Whincup PH, Orfei L, Chou Q-A, Rudnicka AR, Wathern AK, Kaye SJ, Eriksson JG, Osmond C, Cook DG: **Is body mass index before middle age related to coronary heart disease risk in later life? Evidence from observational studies.** *Int J Obes (Lond)* 2009, **33**:866–77.
11. Singh a S, Mulder C, Twisk JWR, van Mechelen W, Chinapaw MJM: **Tracking of childhood overweight into adulthood: a systematic review of the literature.** *Obes Rev* 2008, **9**:474–88.
12. Rennie KL, Johnson L, Jebb SA: **Behavioural determinants of obesity.** *Best Pract Res Clin Endocrinol Metab* 2005, **19**:343–58.
13. Kelder SH, Perry CL, Klepp KI, Lytle LL: **Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors.** *Am J Public Health* 1994, **84**:1121–6.
14. Craigie AM, Lake A a., Kelly S a., Adamson AJ, Mathers JC: **Tracking of obesity-related behaviours from childhood to adulthood: A systematic review.** *Maturitas* 2011, **70**:266–84.
15. Golan M, Crow S: **Parents Are Key Players in the Prevention and Treatment of Weight-related Problems**. *Nutr Rev* 2004, **62**:39–50.
16. Kral TVE, Rauh EM: **Eating behaviors of children in the context of their family environment.** *Physiol Behav* 2010, **100**:567–73.
17. Birch LL, Davison KK: **Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight.** *Pediatr Clin North Am* 2001, **48**:893–907.
18. Story M, Kaphingst KM, French S: **The role of schools in obesity prevention**. *Futur Child* 2006, **16**:109–142.
19. Wechsler H, Devereaux RS, Davis M, Collins J: **Using the School Environment to Promote Physical Activity and Healthy Eating**. *Prev Med (Baltim)* 2000, **31**:S121–S137.
20. Jaime PC, Lock K: **Do school based food and nutrition policies improve diet and reduce obesity?** *Prev Med (Baltim)* 2009, **48**:45–53.
21. Vereecken C, Bobelijn K, Maes L: **School food policy at primary and secondary schools in Belgium-Flanders: does it influence young people's food habits?** *Eur J Clin Nutr* 2005, **59**:271–7.
22. Van Cauwenberghe E, Maes L, Spittaels H, van Lenthe FJ, Brug J, Oppert J-M, De Bourdeaudhuij I: **Effectiveness of school-based interventions in Europe to promote healthy nutrition in children and adolescents: systematic review of published and "grey" literature.** *Br J Nutr* 2010, **103**:781–97.
23. De Bourdeaudhuij I, Van Cauwenberghe E, Spittaels H, Oppert J-M, Rostami C, Brug J, Van Lenthe F, Lobstein T, Maes L: **School-based interventions promoting both physical activity and healthy eating in Europe: a systematic review within the HOPE project.** *Obes Rev* 2011, **12**:205–216.
24. Evans CEL, Christian MS, Cleghorn CL, Greenwood DC, Cade JE: **Systematic review and meta-analysis of school-based interventions to improve daily fruit and vegetable intake in children aged 5 to 12 y.** *Am J Clin Nutr* 2012, **96**:889–901.
25. Kubik MY, Lytle L a, Story M: **Soft drinks, candy, and fast food: what parents and teachers think about the middle school food environment.** *J Am Diet Assoc* 2005, **105**:233–9.
26. Vereecken C, van Houte H, Martens V, Wittebroodt I, Maes L: **Parents' and teachers' opinions about the school food policy in Belgian Flemish nursery schools.** *Int J Environ Res Public Health* 2009, **6**:1268–81.
27. Isoldi KK, Dalton S, Rodriguez DP, Nestle M: **Classroom "cupcake" celebrations: observations of foods offered and consumed.** *J Nutr Educ Behav* , **44**:71–5.
28. Isoldi KK, Dalton S: **Calories in the Classroom: Celebration Foods Offered and Consumed during Classroom Parties at an Elementary School in a Low-Income, Urban Community.** *Child Obes* 2012, **8**:378–83.
29. **The Netherlands Heart foundation** [http://www.hartstichting.nl/actueel/nieuwsoverzicht/nieuwsarchief_2011/bijna_alle_traktaties_op_school_ongezond/]
30. **The Nationale School Fruit Scheme** [http://webarchive.nationalarchives.gov.uk/+/www.dh.gov.uk/en/Publichealth/Healthimprovement/FiveADay/FiveADaygeneralinformation/DH_4002149]
31. **USDA Fruit and Vegetable Program** [http://www.ers.usda.gov/topics/food-nutrition-assistance/child-nutrition-programs/usda-fruit-and-vegetable-program.aspx]
32. **Crunch&Sip** [http://www.crunchandsip.com.au/what-is-crunchsip/]
33. **Schoolguiten** [http://schoolgruiten.kennisnet.nl/watisschoolgruiten]

Children's snack consumption: role of parents, peers and child snack-purchasing behaviour

Results from the INPACT study

Wilke J.C. van Ansem, Carola T.M. Schrijvers, Gerda Rodenburg, Dike van de Mheen
Submitted

Abstract

We hypothesized that children are more likely to buy snacks if these are not always available at home, if restrictive rules apply to their consumption, and if a child is sensitive to peer influence. Therefore, we examined the influence of parents (home snack availability and consumption rules) and peers on 11-year-old children's snack consumption, and whether these associations were mediated by children's snack-purchasing behaviour. Data were taken from 1203 parent-child dyads who completed a questionnaire in the INPACT study. Multivariable regression models was used to 1) analyse associations between children's consumption and parents' and peers' influence, and 2) determine whether these associations were mediated by children's snack-purchasing behaviour.

Of the parental factors, home availability of snacks was associated with higher snack consumption (B=1.03, P<0.05). Parental factors and children's snack-purchasing behaviour were not associated. Children who were sensitive to peer influence consumed more snacks (B= 3·07, P< 0.01) and bought more snacks out of their pocket money (OR= 3.27, *P*<0 0.01). Children's snack-purchasing behaviour explained part (8.6%) of the association between peer influence and children's snack consumption. As these findings indicate that both parents and peers influence children's consumption, health promotion may benefit from targeting the broader social environment.

Introduction

In many affluent countries, the prevalence of childhood obesity is both high and rising [1, 2]. In the Netherlands, too, the prevalence of overweight and obesity has increased in recent years. Between 1980 and 2010, the prevalence of overweight in boys aged 2-21 years almost tripled (from 5.1% to 13.3%); in girls, it increased from 7.2% to 14.9% [3]. Obesity in childhood is associated with various physical and psychosocial problems, not just in childhood, but also beyond [4–7]. Furthermore, childhood obesity tracks into adulthood [8].

Unhealthy dietary behaviour, such as high snack consumption, is associated with increased risk of overweight and obesity [9] Not only has an increase in children's snacking behaviour been reported [10], eating habits established in childhood also track into adulthood [11, 12]. To develop interventions and policy to improve children's dietary habits, it is important to gain greater insight into the determinants of their unhealthy dietary behaviour, including snack consumption.

The home environment is reported to be an important determinant of children's dietary behaviour [13]. Because parents can act as role models, set food rules and determine which foods are available at home, they influence children's eating habits [14]. Although most studies on parental factors and children's dietary behaviour focussed on fruit and vegetable intake [15–17], some have also shown parental factors to be associated with children's snacking behaviour. For example, children's snack consumption is associated with the home availability of snacks: when snacks were available at home, children consumed more snacks [18]. Among boys, it was also found that a lack of food rules was associated with a higher intake of fat [19].

As well as parental influence, other elements in the social environment play a role in children's dietary behaviour. As children grow older, they spend more time with their peers, who can also influence it. A recent review concluded that school friendships may be critical to shaping eating behaviour and body weight: for example, the risk of becoming overweight was higher in children whose friends were overweight [20, 21]. Similarly, a positive association was found between individual and peer snack consumption: adolescents whose friends consumed many snacks themselves ate more snacks than those whose friends ate few snacks [22].

As children age – and possibly receive pocket money – they gain more autonomy and decision-making power with regard to dietary behaviour [13, 23]. However, little is known about the role of economic factors (such as pocket money) on their dietary behaviour. It is generally assumed that parents make decisions that are influenced by economic determinants, although they leave some of these decisions to their children [24] – for example, by providing pocket money which their children can spend on items of their own choice. In the Netherlands, 83 % of children aged 11 years receive pocket money [25]. Although there is very little literature on the role of pocket money as a determinant of children's dietary behaviour, a study by Jensen *et al*. found that children who rarely spend their pocket money on soft drinks have lower soft drink consumption than children who more frequently spend their pocket money on soft drinks [24]. Similarly, two experimental studies found that peers influence children's food-purchasing behaviour [26, 27].

The influence of parents and peers on children's dietary behaviour will depend on the child's age and life stage. While parental influence on children probably decreases in the transition from childhood to adolescence, peer influence tends to become more important, not just generally, but also regarding dietary behaviour [28]. In this study our main purpose was therefore to establish the influence of parents and peers on 11-year-old children's snack consumption. Because pocket money may help increase their autonomy and decision-making power regarding dietary behaviour, and because peers may influence children's food-purchasing behaviour, we also examined whether children's purchasing behaviour mediates the associations between parental and peer influences and children's snack consumption. We hypothesized that children are more likely to buy snacks out of their pocket money if snacks are not always available at home, if there are restrictive rules on their snack consumption, or if they are sensitive to peer influence. We also assume that children who buy snacks out of their pocket money would consume more snacks. Figure 1 presents our research model.

Methods

Study design & population

Data for this study were retrieved from the Dutch INPACT study, INPACT being the acronym for IVO Physical Activity Child cohort. This longitudinal study among 8 to12 year olds and their parents investigated modifiable environmental determinants of children's dietary behaviour and physical activity. The INPACT study had four annual data collection periods (2008-2011), in which trained research assistants visited primary schools and measured children's height and weight. Children completed a short questionnaire at school, and parents completed a questionnaire at home. The questionnaire topics varied annually. Participants in the INPACT study were recruited through primary schools in the southern Netherlands (Eindhoven and surroundings), where all mainstream primary schools (n=265) were invited to participate in the study by the Municipal Health Service. Eventually, 91 took part (34·3%). Response rates from rural and urban schools were similar. A sample of 1844 parent-child dyads (62·5%) gave informed consent. The INPACT study was approved by the Ethical Committee at Erasmus University Medical Centre, Rotterdam. The present study was based on the data collected in its final wave (2011), which was the only wave that collected data on children's snack-purchasing behaviour.

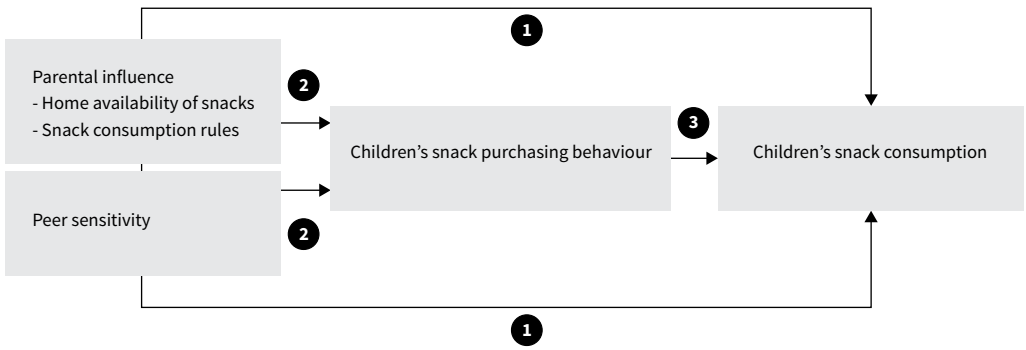

Figure 1 Conceptual research model

Measurements

Children's snack consumption

Children's snack consumption was measured using a questionnaire based on a validated Food Frequency Questionnaire [29, 30]. Children reported how many days in the past seven days they had consumed the following items between meals: 1) savoury snacks (e.g. potato chips, peanuts, sausage rolls); 2) sweet snacks (e.g. candy bars, chocolate, candies); or 3) cake or large biscuits. Examples of the type of foods we considered as snacks were given in the questionnaire. Answering categories ranged from 'none or less than one day a week' to 'seven days a week'. Children reported the number of items they consumed on such a day, with answering categories ranging from '0 items a day' to '10 items or more a day'.
We calculated children's total snack consumption in items per week by multiplying the consumption-frequencies of savoury snacks, sweet snacks and cakes by their corresponding quantities and summing these scores.

Children's snack-purchasing behaviour

We asked children what they usually bought with their pocket money. There were ten answering categories, including separate categories for 'sweet snacks' and 'savoury snacks'. Most of the other categories were non-food items such as 'toys', 'computer games' or 'books'. Children were allowed to report more than one answering category. We created a dichotomous variable 'purchasing snacks' with the answering categories 'yes' (i.e. children bought sweet snacks and/or savoury snacks) and 'no'. Children who did not receive pocket money (n=267, 18.7%) were classified as 'purchasing no snacks'.

Parental influence

Home availability of snacks

The availability of snacks at home was measured using a questionnaire based on the validated Home Environment Survey [31]. Parents were asked to report separately how often 1) sweet snacks and biscuits, and 2) savoury snacks were available at home. Response categories were 'always available', 'usually available', 'sometimes available', 'usually not available' and 'never available'. We created one variable for the home availability of snacks, for which we merged the home availability of sweet snacks and savoury snacks into one variable. Due to the limited variation in these variables, we dichotomised the response categories into 'snacks always available at home' (at least sweet snacks and biscuits or savoury snacks were always available at home); or 'snacks not always available at home' (neither sweet snacks and biscuits nor savoury snacks were always available at home).

Snack-consumption rules

Parents were asked whether they had rules on the number of snacks their children were allowed to consume. The response categories were 'yes' and 'no'. These questions were derived from the Endorse study [32].

Peer sensitivity

To measure the influence of peers on children's dietary intake, we presented the children with the following hypothetical situation: *'After school, you are with some friends. You and your friends decide to go to a supermarket or fast-food restaurant. While you don't intend to buy any snacks, you decide to join your friends. When they're in the supermarket or fast food restaurant, all your fiends buy snacks.'* We asked the children how they would act in such a situation. Two options were available: 'Then I'll buy some food, too' or 'I won't buy any food'. We named the answering categories 'sensitive to peer influence' ('Then I'd buy some snacks, too') and 'not sensitive to peer influence' ('I wouldn't buy any snacks').

Control variables

A child's age was calculated from the date of birth and the date of measurement. For the purpose of analysis we dichotomised a child's age into '≤ 11 years' versus '>11 years'. A child's ethnicity was categorised into 'Dutch native' (both parents were born in the Netherlands) or 'immigrants' (at least one of the parents was born outside the Netherlands). Maternal educational level was used to measure a child's SES. Maternal educational level was classified into three groups: 'low educational level' (primary school and lower secondary education); 'intermediate educational level' (intermediate vocational level, higher secondary school, and pre-university education); and 'high educational level' (higher vocational education and university).
Children's body mass index (BMI) was calculated on the basis of weight and height, which were measured to the nearest 0·1 cm and 0.1 kg when the child was wearing clothes but no shoes; the measurements were made by trained research assistants. Overweight and obesity were defined on the basis of BMI cut-off points for children/adolescents [33]. Child BMI was then dichotomised into 'overweight' ('overweight' and 'obesity') versus non overweight ('underweight and normal weight').

Data analysis

Respondents who lacked data on child snack consumption, child snack-purchasing behaviour, home availability of snacks, snack-consumption rules, peer sensitivity, or control variables (n= 197) were excluded from the analysis.
Descriptive analyses were performed to describe the characteristics of the study population.
Baron and Kenny's four-step approach [34] was used to investigate whether children's snack-purchasing behaviour mediated the associations between a) parental factors (home availability of snacks and

snack-consumption rules) and children's snack consumption; and b) peer influence and children's snack consumption. According to Baron and Kenny, there are three criteria for mediation: 1) the predictive variable has to be associated with the outcome variable, 2) the predictive variable has to be associated with the mediator, and 3) the mediator has to be associated with the outcome variable (adjusted for the predictive variable). If all the associations assessed in steps 1-3 are statistically significant, the criteria for mediation have been met. The fourth step in the approach is to test the mediation model, mediation being supported if the association between the predictive variable and the outcome variable changes after control for the mediation [34].

Depending on the scale of the outcome measures, logistic regression models or linear regression models were used to test the steps of the mediation approach. Bootstrapping resampling techniques were used to calculate confidence intervals for the mediated effects. All regression models were adjusted for the control variables, i.e. child's age, child's gender, child's SES, child's ethnicity and child's BMI. All analyses were performed using IBM SPSS Statistics version 20.0. The bootstrapping analyses were performed using R (2013).

Results

Characteristics of the study population

The characteristics of the study population are presented in table 1. Mean snack consumption was 9·7 items per week. Most children reported that they did not buy snacks out of their pocket money (94.1%); most parents (74.8%) reported that snacks were always available at home; and most (73.9%) reported that they had rules on the amount of snacks their child was allowed to consume. A minority of the children (17.1%) were sensitive to peer influence.

Table 1 Characteristics of the study population (n=1203)

Child's age %	
≤11 years	85.6
> 11 years	14.4
Child's gender %	
Boys	51.1
Girls	48.9
Child's BMI %	
Overweight	11.4
No overweight	88.6
Child's SES %	
Low	19.4
Intermediate	47.5
High	33.1
Child's ethnicity %	
Native Dutch	89.0
Immigrant	11.0

Parental influence

Table 2 presents the results of our analyses of the associations between parental influence, children's snack consumption and children's snack-purchasing behaviour. Children consumed more snacks if these were always available at home (B=1.03, P<0.05). No statistically significant association was found between snack-consumption rules and children's snack consumption. Also, no significant associations were found between the parental variables (home availability and snack consumption rules) and children's snack-purchasing behaviour. This lack of significant associations indicates that the criteria for mediation were not met.

Table 2 Association between parental factors and children's snack consumption (n=1203)†

Step 1: Association between parental influences and children's snack consumption	**Mean consumption of snacks**	**Multivariate regression analyses B (95%CI)**
Home availability of snacks		
Not always*	8.7 (7.9)	9.07
Always	10.0 (7.4)	**1.03 (0.05 – 2.01)**
Rules for snack consumption		
No*	9.7 (8.0)	9.88
Yes	9.7 (7.3)	0.13 (-0.84 – 1.09)
Step 2: Association between home availability of snacks and children's snack-purchasing behaviour		**Multivariate regression analyses OR (95%CI)**
Home availability of snacks	*% children who buy snacks*	
Not always*	6.6	1.00
Always	5.7	0.84 (0.49 – 1.45)
Rules for snack consumption	*% children who buy snacks*	
No*	6.1	1.00
Yes	5.8	0.99 (0.58 – 1.71)

† Multivariate linear regression analysis adjusted for child's age, child's gender, child's SES, child's ethnicity and child's BMI.
B= unstandardized coefficient, OR= Odds Ratio, 95%CI= 95% Confidence interval
* Reference group; Bold values represent statistically significant associations

Peer sensitivity

Table 3 presents the results of our analyses of the associations between peer sensitivity, children's snack consumption and children's snack-purchasing behaviour. Children who were sensitive to peer influence consumed more snacks (B= 3·07, P< 0.01) and bought more snacks out of their pocket money than those who were not (OR= 3.27, *P*<0 0.01). As expected, their purchasing behaviour was also significantly associated with their snack consumption. The mediation analyses showed that purchasing behaviour explained 8.6% of the association between peer influence and children's snack consumption.

Table 3 Association between peer influence, children's snack-purchasing behaviour and children's snack consumption (n=1203)†

Step 1: Association between peer influence and children's snack consumption	**Mean snack consumption**	**Multivariate regression analyses B (95%CI)**	
Sensitive to peer influence			
No*	9.2 (7.1)	9.41	
Yes	12.3 (8.8)	**3.07 (1.96 – 4.18)**	
Step 2: Association between peer influence and children's snack-purchasing behaviour		**Multivariate regression analyses OR (95%CI)**	
	% children who buy snacks		
Sensitive to peer influence			
No*	4.4	1.00	
Yes	13.1	**3.27 (1.95 – 5.47)**	
Step 3: Association between children's snack-purchasing behaviour and their snack consumption	**Mean consumption of snacks**	**Multivariate regression analyses B (95%CI)**	
Bought snacks			
No*	9.5 (7.3)	9.22	
Yes	13.2 (9.2)	**3.00 (1.22 – 4.78)**	
Step 4: Mediation analyses	**B model step 1**	**Multivariate regression analyses B (95%CI) ††**	**% Change (95 CI)**
Sensitive to peer influence			
No*	9.41	9.22	
Yes	3.07	**2.81 (1.70 – 3.93)**	- 8.6% (- 18.99 - -2.14)

† Multivariate linear regression analysis adjusted for child's age, child's gender, child's SES, child's ethnicity and child's BMI.
†† Multivariate mediation analysis adjusted for children's snack purchasing behaviour, child's age, child's gender, child's SES, child's ethnicity and child's BMI.
B= unstandardized coefficient, OR= Odds Ratio, 95%CI= 95% Confidence interval * Reference group
Bold values represent statistically significant associations

Discussion

While parents and peers are all likely to influence children's dietary behaviour, their actual influence may depend on the age and life stage of the individual child. This is one of the first studies to investigate the influences of parents and peers on the snack consumption of 11-year-old children.

Of the parental factors explored in this study, home availability and children's snack consumption were significantly associated – a finding that is consistent with a previous study by Pearson *et al* [18]. However, studies on family food rules and children's snack consumption yielded mixed results. While a European study [19] found that a lack of family food rules regarding unhealthy products was associated with higher fat intake in boys, an American study [35] found no association between household eating rules related to unhealthy products and children's dietary fat intake. A possible explanation for the fact that we failed to find an association between snack-consumption rules and children's snack consumption is that children also consume snacks at school or with friends, thereby not conforming to parental rules when they are not at home.

Although peers have been reported to play an important role in children's and adolescents' dietary behaviour [36, 37], and although our own results show a statistically significant association between peer influence and children's snack consumption, other studies found no evidence for peer influence on children's dietary behaviour [35, 38]. One possible explanation for this inconsistency is that the measurements of peer influence may have varied between these studies.

Similarly, an important role in children's dietary behaviour may be played by economic factors, including pocket money [24, 39]. To our knowledge, our study is one of the first to examine the role of children's food-purchasing behaviour as a determinant of their snack consumption. While, as expected, it showed children's snack-purchasing behaviour to be statistically significantly associated with their snack consumption, the number of children actually purchasing snacks out of their pocket money was relatively small because the children would have had limited opportunities to buy snacks during school time (Dutch primary schools having no canteen or vending machines). Despite this small number, children's snack-purchasing behaviour mediated the association between peer influence and child's snack consumption. Although this mediation effect was small, we can reasonably that more snacks will be bought by children at secondary school, or by children in countries where snacks can be bought during school time.

Our study has the following limitations. The first is that our statistical analyses were based on a cross-sectional dataset, which makes it more difficult to draw conclusions on any causal relationships. The second is that most of our data except that on child BMI were parent or child reports, which may thus have elicited socially desirable answers – for example, children may have underestimated their snack consumption.

A third limitation is that whereas one variable, children's snack consumption, was composed of three separate questions on 1) savoury snacks, 2) sweet snacks, and 3) cake or large biscuits, the measurements of the home availability of snacks, child snack-purchasing behaviour, and snack-consumption rules refer only to savoury snack or sweets, and not explicitly to biscuits. This may have led to some underreporting on the availability of snacks at home, on children's snack-purchasing behaviour, or on snack-consumption rules. However, any selective underreporting of any of these variables would probably have led the associations to be underestimated. The fourth limitation is that we measured peer sensitivity on the basis of the children's answers to how they would act in a hypothetical situation – we did not measure their

actual behaviour when they spent time with their friends. Although it may be difficult for children to answer such questions, trained research assistants were available to help them complete the questionnaire in the classroom. For this reason, we do not believe such a difficulty will have affected our results substantially.

In conclusion, our study indicates that parents and peers both influence 11-year-old children's snack consumption. As the association between peer influence and snack consumption was mediated by the children's snack-purchasing behaviour, it might be useful to target this behaviour in health promotion. Similarly, the involvement of parents and peers may benefit interventions intended to reduce children's snack consumption and to promote healthy eating habits. Finally, as parents' and peers' influence on children's dietary behaviour may differ between younger and older children, these influences should be further examined in the different age groups.

References

1. Kosti RI, Panagiotakos DB: **The epidemic of obesity in children and adolescents in the world.** *Cent Eur J Public Health* 2006, **14**:151–9.
2. Wang Y, Lobstein T: **Worldwide trends in childhood overweight and obesity**. *Int J Pediatr Obes* 2006, **1**:11–25.
3. Schönbeek Y, Van Buuren S: *Factsheet Resultaten Vijfde Landelijke Groeistudie*. 2010.
4. Han JC, Lawlor DA, Kimm SYS: **Childhood obesity.** *Lancet* 2010, **375**:1737–48.
5. Daniels SR: **Complications of obesity in children and adolescents.** *Int J Obes (Lond)* 2009, **33 Suppl 1**:S60–5.
6. Owen CG, Whincup PH, Orfei L, Chou Q-A, Rudnicka AR, Wathern AK, Kaye SJ, Eriksson JG, Osmond C, Cook DG: **Is body mass index before middle age related to coronary heart disease risk in later life? Evidence from observational studies.** *Int J Obes (Lond)* 2009, **33**:866–77.
7. Gilliland FD: **Obesity and the Risk of Newly Diagnosed Asthma in School-age Children**. *Am J Epidemiol* 2003, **158**:406–415.
8. Singh a S, Mulder C, Twisk JWR, van Mechelen W, Chinapaw MJM: **Tracking of childhood overweight into adulthood: a systematic review of the literature.** *Obes Rev* 2008, **9**:474–88.
9. Nicklas TA, Yang S-J, Baranowski T, Zakeri I, Berenson G: **Eating patterns and obesity in children**. *Am J Prev Med* 2003, **25**:9–16.
10. Piernas C, Popkin BM: **Trends in snacking among U.S. children.** *Health Aff (Millwood)* 2010, **29**:398–404.
11. Kelder SH, Perry CL, Klepp KI, Lytle LL: **Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors.** *Am J Public Health* 1994, **84**:1121–6.
12. Craigie AM, Lake A a., Kelly S a., Adamson AJ, Mathers JC: **Tracking of obesity-related behaviours from childhood to adulthood: A systematic review.** *Maturitas* 2011, **70**:266–84.
13. Verloigne M, Van Lippevelde W, Maes L, Brug J, De Bourdeaudhuij I: **Family- and school-based correlates of energy balance-related behaviours in 10-12-year-old children: a systematic review within the ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project.** *Public Health Nutr* 2012, **15**:1380–95.
14. Lindsay AC, Sussner KM, Kim J, Gortmaker S: **The role of parents in preventing childhood obesity.** *Future Child* 2006, **16**:169–86.
15. Pearson N, Biddle SJH, Gorely T: **Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review.** *Public Health Nutr* 2009, **12**:267–83.
16. Krølner R, Rasmussen M, Brug J, Klepp K-I, Wind M, Due P: **Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part II: qualitative studies.** *Int J Behav Nutr Phys Act* 2011, **8**:112.
17. Van der Horst K, Oenema a, Ferreira I, Wendel-Vos W, Giskes K, van Lenthe F, Brug J: **A systematic review of environmental correlates of obesity-related dietary behaviors in youth.** *Health Educ Res* 2007, **22**:203–26.
18. Pearson N, Ball K, Crawford D: **Predictors of changes in adolescents' consumption of fruits, vegetables and energy-dense snacks.** *Br J Nutr* 2011, **105**:795–803.
19. Haerens L, Craeynest M, Deforche B, Maes L, Cardon G, Bourdeaudhuij I De, De Bourdeaudhuij I: **The contribution of psychosocial and home environmental factors in explaining eating behaviours in adolescents.** *Eur J Clin Nutr* 2008, **62**:51–9.
20. Fletcher A, Bonell C, Sorhaindo A: **You are what your friends eat: systematic review of social network analyses of young people's eating behaviours and bodyweight.** *J Epidemiol Community Health* 2011, **65**:548–55.
21. Halliday TJ, Kwak S: **Weight gain in adolescents and their peers.** *Econ Hum Biol* 2009, **7**:181–90.
22. Wouters EJ, Larsen JK, Kremers SP, Dagnelie PC, Geenen R: **Peer influence on snacking behavior in adolescence.** *Appetite* 2010, **55**:11–7.
23. Golan M, Crow S: **Parents Are Key Players in the Prevention and Treatment of Weight-related Problems**. *Nutr Rev* 2004, **62**:39–50.
24. Jensen JD, Bere E, Bourdeaudhuij I De, Jan N, Maes L, Manios Y, Martens MK, Molnar D, Moreno LA, Singh AS, Velde S, Brug J, De Bourdeaudhuij I, Te Velde S: **Micro-level economic factors and incentives in Children's energy balance related behaviours - findings from the ENERGY European cross-section questionnaire survey.** *Int J Behav Nutr Phys Act* 2012, **9**:136.
25. **NIBUD (National Institute For Familiy Finance Information** [http://www.nibud.nl/omgaan-met-geld/kinderen-en-geld/zakgeld.html]
26. Bevelander KE, Anschütz DJ, Engels RCME: **Social modeling of food purchases at supermarkets in teenage girls.** *Appetite* 2011, **57**:99–104.
27. Salvy S-J, Kluczynski MA, Nitecki LA, O'Connor BC: **Peer influence on youth's snack purchases: a laboratory analog of convenience store shopping.** *Eat Behav* 2012, **13**:233–9.
28. Salvy S, Elmo A, Nitecki LA, Kluczynski MA, Roemmich JN: **Influence of parents and friends on children's and adolescents' food intake and food selection.** *Am J Clin Nutr* 2011, **93**:87–92.
29. Bogers RP, Van Assema P, Kester ADM, Westerterp KR, Dagnelie PC: **Reproducibility, validity, and responsiveness to change of a short questionnaire for measuring fruit and vegetable intake.** *Am J Epidemiol* 2004, **159**:900–9.
30. Haraldsdóttir J, Thórsdóttir I, de Almeida MDV, Maes L, Pérez Rodrigo C, Elmadfa I, Frost Andersen L: **Validity and reproducibility of a precoded questionnaire to assess fruit and vegetable intake in European 11- to 12-year-old schoolchildren.** *Ann Nutr Metab* 2005, **49**:221–7.

31. Gattshall ML, Shoup JA, Marshall JA, Crane LA, Estabrooks PA: **Validation of a survey instrument to assess home environments for physical activity and healthy eating in overweight children.** *Int J Behav Nutr Phys Act* 2008, **5**:3.
32. Van der Horst K, Oenema A, van de Looij-Jansen P, Brug J: **The ENDORSE study: research into environmental determinants of obesity related behaviors in Rotterdam schoolchildren.** *BMC Public Health* 2008, **8**:142.
33. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH: **Establishing a standard definition for child overweight and obesity worldwide: international survey.** *BMJ* 2000, **320**:1240–3.
34. Baron RM, Kenny DA: **The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations.** *J Pers Soc Psychol* 1986, **51**:1173–82.
35. Zabinski MF, Daly T, Norman GJ, Rupp JW, Calfas KJ, Sallis JF, Patrick K: **Psychosocial correlates of fruit, vegetable, and dietary fat intake among adolescent boys and girls.** *J Am Diet Assoc* 2006, **106**:814–21.
36. Salvy S, Howard M, Read M, Mele E: **The presence of friends increases food intake in youth.** *Am J Clin Nutr* 2009, **90**:282–7.
37. Salvy S-J, de la Haye K, Bowker JC, Hermans RCJ: **Influence of peers and friends on children's and adolescents' eating and activity behaviors.** *Physiol Behav* 2012, **106**:369–78.
38. Finnerty T, Reeves S, Dabinett J, Jeanes YM, Vögele C: **Effects of peer influence on dietary intake and physical activity in schoolchildren.** *Public Health Nutr* 2010, **13**:376–83.
39. Jensen JD, Hartmann H, de Mul A, Schuit A, Brug J: **Economic incentives and nutritional behavior of children in the school setting: a systematic review.** *Nutr Rev* 2011, **69**:660–74.

part two

Socio-economic inequalities in children's dietary behaviour and the influence of environmental determinants

chapter 5

maternal

Maternal educational level and children's healthy eating behaviour: role of the home food environment

Cross-sectional results from the Dutch INPACT study

Maternal educational level and children's healthy eating behaviour: role of the home food environment

Cross-sectional results from the Dutch INPACT study

Wilke J.C. van Ansem, Carola T.M. Schrijvers, Gerda Rodenburg, Dike van de Mheen
Int J Behav Nutr Phys Act. 2014; 11(1):113

Abstract

Background: The aims of this study are 1) to investigate the association between maternal educational level and healthy eating behaviour of 11-year-old children (fruit, vegetables and breakfast consumption), and 2) to examine whether factors in the home food environment (parental intake of fruit, vegetables and breakfast; rules about fruit and vegetables and home availability of fruit and vegetables) mediate these associations.

Methods: Data were obtained from the Dutch INPACT study. In total, 1318 parent-child dyads were included in this study. Multilevel regression models were used to investigate whether factors of the home food environment mediated the association between maternal educational level and children's healthy eating behaviour.

Results: Children of mothers with a high educational level consumed more pieces of fruit per day (B=0.13, 95% CI: 0.04-0.22), more grams of vegetables per day (B=23.81, 95% CI=14.93-32.69) and were more likely to have breakfast on a daily basis (OR=2.97, 95% CI: 1.38-6.39) than children of mothers with a low educational level. Home availability, food consumption rules and parental consumption mediated the association between maternal education level and children's fruit and vegetable consumption. Parental breakfast consumption mediated the association between maternal education level and children's breakfast consumption.

Conclusions: Factors in the home food environment play an important role in the explanation of socio-economic disparities in children's healthy eating behaviour and may be promising targets for interventions.

Introduction

Dietary behaviour is important for the development and growth of children and also influences health outcomes later in life. Fruit and vegetables and daily breakfast consumption are important components of a healthy diet and their beneficial effects on health are well documented. Diets rich in fruit and vegetables protect against cardiovascular disease (CVD), some types of cancer, and obesity [1, 2]. Regular breakfast consumption is associated with better cognitive performance and a reduced risk of becoming overweight or obese among children and adolescents [3, 4]. Despite the importance of healthy dietary behaviours, the majority of the children in the Netherlands, as in other countries, does not consume the recommended amounts of fruit and vegetables [5–8]. In addition, breakfast skipping is highly prevalent in Europe and the United States [9, 10]. Also, because dietary habits track into adulthood, it is important to develop interventions aimed to improve dietary behaviours of children [11, 12].

Children and adolescents with a low socio-economic status (SES) consume less fruit and vegetables than children and adolescents with a high SES [13–16]. Furthermore, a Norwegian study found an increase in socio-economic disparities in adolescent's fruit and vegetable consumption between 2001 and 2008 [17]. Studies of socio-economic disparities in breakfast consumption showed inconsistent findings. A literature review found that parental educational level and parental unemployment were unrelated to adolescents and children's breakfast consumption [18]. However, other studies found a positive association between maternal educational level and children's breakfast consumption [9, 19, 20]. Given the inconsistencies in the findings from previous studies and the relative small part of the literature assessing socio-economic disparities in dietary behaviour of children, the first aim of this study is to investigate socio-economic differences in healthy eating behaviours of children (fruit, vegetable and breakfast consumption).

The home food environment is important in the development of children's dietary behaviour [21]. Parents have an important influence on the dietary behaviour of children because they generally determine which food is available at home, they can set rules about what their children are allowed to eat and they act as role models, also with respect to dietary behaviour [22]. Several literature reviews concluded that aspects of the home environment are associated with children's fruit and vegetable intake [16, 23, 24]. Home environmental factors found to be positively related to children's fruit and vegetable intake are home availability, family rules and parental intake. For breakfast consumption, parental breakfast consumption is an important home environmental factor that is positively associated with children's breakfast consumption [18].

As stated before, the first aim of this study is to investigate socio-economic differences (maternal educational level is used as indicator for children's SES) in healthy eating behaviours of children. However, SES does not directly influence dietary behaviour and is not a modifiable correlate of children's dietary behaviour. Thus it is important to identify modifiable determinants that may explain the socio-economic disparities in children's healthy eating behaviour. Therefore, the second aim of this study is to examine whether factors in the home food environment (parental intake of fruit, vegetables and breakfast; rules about fruit and vegetables and home availability of fruit and vegetables) mediate the association between maternal educational level and children's healthy eating behaviours (fruit, vegetable and breakfast consumption). Figure 1 presents the research model.

Methods

Study population and design

The data used in this study are derived from the Dutch INPACT study, INPACT being the acronym for IVO Nutrition Physical Activity Child cohort. This longitudinal study among 8 to 12 year olds and their parents investigated modifiable environmental determinants of children's dietary behaviour. Participants of the INPACT study were recruited through primary schools in the southern part of the Netherlands (Eindhoven and surroundings). The municipal health service invited all general primary schools (n=265) in this area to participate in this study. Ninety one schools (34.3%) agreed. The response rate of schools in rural and urban areas was similar. A sample of 1844 parent-child dyads (62.5%) gave informed consent. Trained research assistants visited the participating primary schools and measured children's height and weight. Children completed a short questionnaire at school and parents completed a questionnaire at home. The questionnaire topics varied annually. The INPACT study was approved by the Medical Ethical Committee at Erasmus Medical Centre, Rotterdam. The present study was based on cross-sectional data collected in the last wave (2011), in which a questionnaire was completed by 1428 primary caregivers. In most cases (n=1312, 92.1%) the primary caregiver was the mother.

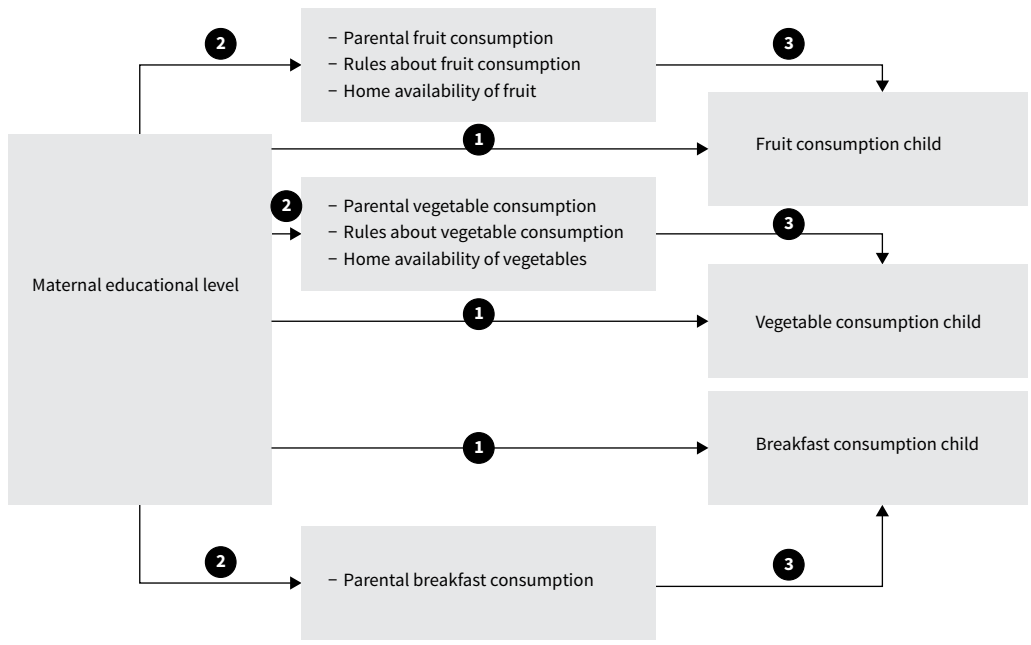

Figure 1 Research model

Measurements

Socio-economic status

The three most commonly used indicators of SES are educational level, income and occupation [25]. Of these three SES indicators, educational level was found to be the strongest and most consistent in predicting health behaviour [25]. In this study, maternal educational level was used as an indicator of children's SES because several studies found maternal educational level to be a reliable determinant of children's dietary behaviour and childhood obesity [9, 19, 20]. In addition, traditionally, in the majority of the households the mother provides the food for the family and, therefore, maternal educational level also impacts the dietary behaviour of the other members of the family and the home availability of foods. Maternal educational level was classified into three groups: 'low educational level' (primary school and lower secondary education), 'intermediate educational level' (intermediate vocational level, higher secondary school and pre-university education) and 'high educational level' (higher vocational education and university).Throughout the remainder of this paper we thus refer to 'low SES' (children of mothers with a low educational level), 'intermediate SES' (children of mothers with an intermediate educational level) and 'high SES' (children of mothers with a high educational level).

Outcome measures (children's fruit, vegetable and breakfast consumption)

Children's fruit, vegetable and breakfast consumption were measured with a questionnaire based on a validated Food Frequency Questionnaire [26–29]. Parents reported how many days in a normal week their child consumed 1) fruit (fresh or canned fruit), 2) cooked, fried, steamed or otherwise heated vegetables, 3) salad or other raw vegetables and 4) breakfast. Answering categories ranged from 'none or less than one day a week' to '7 days a week'.

Additionally, parents reported the numbers of servings of fruit and vegetables consumed by their child on such a day. For fruit, answer categories ranged from '0 pieces a day' to 'more than 3 pieces a day', by increments of half a piece of fruit. Reported fruit consumption of more than 3 pieces a day (n=4) was recoded as '4 pieces a day'. For vegetables, answer categories ranged from '0 serving spoons' to 'more than 4 serving spoons a day', by increments of half a serving spoon. Reported vegetable consumption of more than 4 serving spoons (n=12) was recoded as '5 serving spoons a day'. One serving spoon of vegetables was equivalent to 50 grams of vegetables. Total vegetable consumption was calculated in grams for each child by multiplying consumption frequency (how many days a child consumed vegetables) and serving spoons of vegetables. Subsequently, the vegetable consumption was converted to an amount consumed in a day. Total fruit consumption was calculated in pieces for each child by multiplying consumption frequency (how many days a child consumed fruit) and servings (pieces of fruit). Children's fruit consumption was also converted to an amount consumed in a day.

Breakfast consumption was dichotomized into 'daily' and 'not daily', due to limited variation in the answering categories.

Potential mediating variables

Parental intake of fruit, vegetables and breakfast

Parental fruit, vegetable and breakfast consumption were measured and calculated in the same way as children's fruit, vegetable and breakfast consumption.

Rules about fruit and vegetable consumption

We assessed whether parents set rules regarding their child's fruit and vegetable consumption with the following questions: 'Do you have the rule that your child should eat 2 pieces of fruit a day?' and 'Do you have the rule that your child should eat 200 grams of vegetables a day?' These specific amounts of fruit and vegetables are consistent with the Dutch guidelines for fruit and vegetables [30]. Response categories were 'yes' and 'no'. These questions were derived from the ENDORSE study [31].

Home availability of fruit and vegetables

The availability of fruit and vegetables at home was measured using a questionnaire based on the validated Home Environment Survey [32]. Parents were asked about the availability of 1) fruit and 2) vegetables in their home. Response categories were 'yes, always', 'yes, usually', 'sometimes', 'no, usually not' and 'no, never'. Due to limited variability of these variables, we dichotomized both variables into 'always' ('yes, always') and 'not always' ('yes, usually'; 'sometimes'; 'no, usually not'; 'no, never').

Potential confounders

The following variables are considered as potential confounders: age, gender, ethnicity and body mass index (BMI) of the child. Age, gender and ethnicity of the child were reported by the parents. A child's age (in years) was calculated on the basis of the date of birth and the date of measurement. For the purpose of analysis we dichotomised child's age into '≤ 11 years' versus '> 11 years. Children's ethnicity was categorised into 'Dutch native' (both parents born in the Netherlands) and 'immigrants' (at least one of the parents was born outside the Netherlands). Children's body mass index (BMI) was calculated on the basis of weight and height, which were measured with clothes but without shoes to the nearest 0.1 kg and 0.1 cm; the measurements were made by trained research assistants. BMI cut-off points for children were used to define overweight and obesity [33]. Subsequently child BMI was dichotomised into 'overweight' ('overweight' and 'obesity') versus no overweight ('underweight and normal weight').

Data analysis

Respondents who lacked data for maternal educational level were excluded from this study (n=110, 7.7%). In total, 1318 children and parents were included in this study. Descriptive analyses were performed to describe the characteristics of the study population.

To investigate whether home environmental factors mediated the association between maternal educational level and children's healthy eating behaviour, we used Baron and Kenny's four-step approach [34]. According to Baron and Kenny, there are three criteria for mediation: 1) the predictive variable has to be associated with the outcome variable, 2) the predictive variable has to be associated with the mediator, and 3) the mediator has to be associated with the outcome variable (adjusted for the predictive variable).

If all the associations assessed in steps 1-3 are statistically significant, the criteria for mediation have been met. Step four of the approach is to test the mediation model: mediation is supported if the association between the predictive variable and the outcome variable changes after controlling for the mediator.
For each outcome measure (child fruit intake, child vegetable intake and child breakfast consumption) the steps of the mediation approach were conducted separately. Depending on the scale of the outcome measures, logistic regression models or linear regression models were used to test the subsequent steps of the mediation- approach.
Several potential mediators were tested for the outcome measures 'child's fruit consumption' and 'child's vegetable consumption'. If it appeared that more than one potential mediator met the criteria for mediation, the unique contribution of each mediator was determined (single mediator model). Next, a multivariate mediation model was tested. Bootstrapping resampling techniques were used to calculate confidence intervals for the mediated effects.
All regression models were adjusted for the potential confounders. Due to the used sample-strategy (children were recruited trough schools), the data have a nested structure (children within schools). To take into account potential clustering effects, we investigated the associations using multilevel regression analyses. Analyses were performed using R (2013). Cases with missing values were removed per analysis. Due to missing values the computed models for fruit, vegetable and breakfast consumption are based on different numbers of participants.

Results

Background characteristics of the study population are presented in Table 1. Mean age of the children was 11 years, the majority was native Dutch and not overweight, and about half were boys. Significant differences between the three educational levels were found in the background characteristics: relative to the high and low SES groups there were more girls in the intermediate SES group. More children in the low SES group were overweight, were older than 11 years, and were immigrants compared with children in the intermediate and high SES groups.

Table 1 Characteristics of the study population: total sample and sample according to socio-economic status (SES)

	Total sample	Low SES	Intermediate SES	High SES	P-value
Mean age N (%)	N=1317	N=263	N=628	N=426	**0.00**
≤11 years	1119 (85.0)	205 (77.9)	528 (84.1)	386 (90.6)	
> 11 years	198 (15.0)	58 (22.1)	100 (15.9)	40 (9.4)	
Gender %	N=1318	N=263	N=629	N=426	**0.02**
Boys	50.8	52.5	46.7	55.6	
Girls	49.2	47.5	53.3	44.4	
Child's BMI %	N=1283	N=252	N=616	N=415	**0.01**
Overweight	11.2	16.7	10.6	8.9	
No overweight	88.8	83.3	89.4	91.9	
Child's ethnicity %	N=1318	N=263	N=629	N=426	**0.02**
Native Dutch	88.8	84.4	90.9	89.4	
Immigrant	11.2	15.6	9.1	10.6	

Fruit consumption

Table 2 provides data on children's fruit consumption and determinants of children's fruit consumption stratified by SES. Children with a low SES had the lowest fruit consumption (on average 0.96 pieces per day) while children with a high SES had the highest fruit consumption (on average 1.07 per day). Table 3 presents data on the association between children's SES and their fruit consumption. Children with a high SES consumed more fruit than children with a low SES (B=0.13, 95%CI: 0.04-0.22). There was no significant difference in fruit consumption between children with an intermediate SES and those with a low SES.
Table 4 presents data on the association between children's SES and possible mediating variables regarding fruit consumption. Parents with a high SES consumed significantly more fruit (B=0.25, 95%CI: 0.13-0.36), were more likely to have rules about fruit consumption (OR=1.78, 95%CI: 1.23-2.56) and were more likely to always have fruit available at home (OR=2.24, 95%CI: 1.25-4.00) than parents with a low SES. Parents with an intermediate SES were also more likely to always have fruit available at home than parents with a low SES (OR=1.74, 95%CI: 1.05-2.88).
Table 5 shows that parental fruit intake, rules about fruit consumption and home availability of fruit were significantly associated with children's fruit consumption. If parents increased their fruit consumption by one piece per day, their children increased their fruit consumption by 0.34 pieces per day. Children of parents who had fruit consumption rules were more likely to consume fruit than children of parents who had no fruit consumption rules. Children of parents who always had fruit available at home were also more likely to consume fruit than children of parents who did not always have fruit available at home.
Table 6 presents the mediation analyses. In the single-mediator models, parental fruit intake explained 66.0% of the difference between children with a low SES and those with a high SES; fruit consumption rules explained 40.9% and home availability of fruit explained 23.2% of the difference in fruit intake. In the multiple-mediator models, parental fruit intake, fruit consumption rules and home availability of fruit together explained 89.5% of the difference in fruit intake between children with a low SES and those with a high SES. Parental fruit intake, fruit consumption rules and home availability of fruit had no significant mediating effect on the difference in fruit intake between children with an intermediate SES and those with a low SES.

Table 2 Descriptives of the key study variables

	Socio-economic status (SES)		
	Low	Intermediate	High
Fruit (N= 1269)	N = 247	N= 607	N=415
Children's fruit intake, pieces per day (mean, SD)	0.96 (0.65)	0.99 (0.57)	1.07 (0.60)
Parental fruit intake, pieces per day (mean, SD)	0.97 (0.74)	1.04 (0.74)	1.19 (0.73)
Parental rules regarding fruit consumption (%)			
Yes	68.8	72.7	79.5
No	31.2	27.3	20.5
Home availability of fruit %			
Always	88.3	92.8	94.2
Not always	11.7	7.2	5.8
Vegetables (N=1265)	N=248	N=606	N=411
Children's vegetable intake, grams per day (mean, SD)	94.0 (57.7)	100.5 (53.1)	116.9 (60.6)
Parental vegetable intake, grams per day (mean, SD)	148.3 (68.1)	158.4 (67.9)	176.7 (68.0)
Parental rules regarding vegetable consumption (%)			
Yes	83.5	85.0	92.0
No	16.5	15.0	8.0
Home availability of vegetables			
Always	83.1	89.4	90.5
Not always	16.4	8.0	9.5
Breakfast (N=1270)	N=246	N=610	N=414
Children's breakfast consumption (%)			
Daily	91.9	94.3	97.3
Not daily	8.1	5.7	2.7
Parental breakfast consumption (%)			
Daily	83.7	91.3	95.7
Not daily	16.3	8.7	4.3

Vegetable consumption

Table 2 provides data on children's vegetable consumption and determinants of children's vegetable consumption stratified by SES. Children with a low SES had the lowest vegetable consumption (on average 94.0 grams per day) while children with a high SES had the highest vegetable consumption (on average 116.9 grams per day).

Table 3 shows significant socio-economic differences in children's vegetables consumption. Children with an intermediate SES and children with a high SES consumed more vegetables than children with a low SES (resp. B = 8.33, 95%CI: 0.09-16.56; B = B = 23.81, 95%CI: 14.93-32.96).

Table 4 presents data on the association between SES and possible mediating variables regarding vegetable consumption. Parents with a high SES consumed more vegetables (B=28.86, 95%CI: 18.05-39.67), were more likely to have vegetable consumption rules (OR=2.47, 95%CI: 1.49-4.10), and were more likely to always have vegetables available at home (OR=1.93, 95%CI: 1.19-3.11) than parents with a low SES. Parents with an intermediate SES also consumed more vegetables (B=11.29 95%CI: 1.24-21.34) and were more likely to have rules about vegetable consumption (OR: 1.74, 95%CI: 1.13-2.69) than parents with a low SES. All potential mediators were significantly associated with children's vegetable consumption (see Table 5). Children consumed more vegetables when their parents consumed more vegetables (B=0.46, 95% CI: 0.42-0.47), when their parents had rules about vegetable consumption (OR=24.94, 95% CI: 15.20-34.68), and when vegetables were always available at home (B=18.62, 95% CI: 9.72-27.51).

Table 6 presents the mediation models. In the single-mediator models, parental vegetable intake explained 56.1% of the difference in vegetable consumption between children with a low SES and those with a high SES; vegetable consumption rules explained 9.9% and home availability of fruit explained 6.0%. In the multiple-mediator model, all the mediators together explained 58.89% of the difference in vegetable intake between children with a low SES and those with a high SES. Parental vegetable intake, vegetable consumption rules and home availability of vegetables had no significant mediating effect on the difference in vegetable intake between children with an intermediate SES and those with a low SES.

Table 3 Associations between socio-economic status (SES) and children's fruit, vegetable and breakfast consumption

Fruit consumption (N=1269)	*Multivariate regression analyses †*	
SES	*B (95%CI)*	*P-value*
Low (Ref. group)	0.84	
Intermediate	0.04 (-0.05 – 0.13)	0.38
High	**0.13 (0.04 – 0.22)**	**0.01**
Vegetable consumption (N=1265)	*Multivariate regression analyses †*	
SES	*B (95%CI)*	*P-value*
Low (Ref. group)	83.89	
Intermediate	**8.33 (0.10 – 16.56)**	**0.05**
High	**23.81 (14.93 – 32.69)**	**0.00**
Breakfast consumption (N=1270)	*Multivariate regression analyses †*	
SES	*OR(95% CI)*	*P-value*
Low (Ref. group)	1.00	
Intermediate	1.39 (0.78 – 2.49)	0.27
High	**2.97 (1.38 -6.39)**	**0.01**

B= unstandardized coefficient, OR= Odds ratio, 95%CI= 95% Confidence Interval. Bold values represent statistically significant association. † Multivariate regression analysis adjusted for: child's age, child's gender, child's ethnicity and child's BMI.

Breakfast consumption

Table 2 presents data on children's and parents breakfast consumption. Children and parents with a high SES more often reported to have breakfast on a daily basis than children and parents with a low and intermediate SES. Table 3 reports on the association between SES and children's breakfast consumption. Children with a high SES were more likely to eat breakfast on a daily basis than children with a low SES (OR=2.97, 95% CI: 1.38-6.39). There was no statistical significant difference in breakfast consumption between children with an intermediate SES and those with a low SES.

Parents with high and intermediate SES were more likely to consume breakfast on a daily basis than parents with a low SES (see Table 4). Table 5 shows that children were more likely to eat breakfast on a daily basis when their parents ate breakfast on a daily basis (OR=15.75, 95%CI: 9.04-27.44). Table 6 shows the final mediation model; parental breakfast consumption explained 67.9% of the differences in breakfast consumption between children with a high SES and those with a low SES. Parental breakfast consumption had no significant mediating effect on the difference in breakfast consumption between children with an intermediate and with a high SES.

Table 4 Associations between socio-economic status (SES) and the mediating variables

Fruit consumption (N=1269)	Mediators	*Multivariate regression analyses* †	
SES	*Parental fruit intake*	*B (95%CI)*	*P-value*
Low (Ref. group)		0.88	
Intermediate		0.09 (-0.02 – 0.20)	0.10
High		**0.25 (0.13 – 0.36)**	**0.00**
SES	*Parental rules regarding fruit intake*	*OR (95%CI)*	*P-value*
Low (Ref. group)		1.00	
Intermediate		1.18 (0.85-1.64)	0.32
High		**1.78 (1.23 – 2.56)**	**0.00**
SES	*Home availability of fruit*	*OR (95%CI)*	*P-value*
Low (Ref. group)		1.00	
Intermediate		**1.74 (1.05 – 2.88)**	**0.03**
High		**2.24 (1.25 – 4.00)**	**0.01**
Vegetable consumption (N=1265)	Mediators	*Multivariate regression analyses* †	
SES	*Parental vegetable intake*	*B (95%CI)*	*P-value*
Low (Ref. group)		144.99	
Intermediate		**11.29 (1.24 – 21.34)**	**0.03**
High		**28.86 (18.05 – 39.67)**	**0.00**
SES	*Parental rules regarding vegetable intake*	*OR* (95% CI)	*P-value*
Low (Ref. group)		1.00	
Intermediate		**1.74** (1.13 – 2.69)	**0.01**
High		**2.47** (1.49 – 4.10)	**0.00**
SES	*Home availability of vegetables*	*OR(95% CI)*	*P-value*
Low (Ref. group)		1.00	
Intermediate		1.18 (0.78 – 1.77)	0.44
High		**1.93 (1.19 – 3.11)**	**0.01**
Breakfast consumption (N=1270)	Mediator	*Multivariate regression analyses* †	
SES	*Parental breakfast intake*	*OR(95% CI)*	*P-value*
Low (Ref. group)		1.00	
Intermediate		**1.94 (1.24 – 3.04)**	**0.00**
High		**4.10 (2.28 – 7.37)**	**0.00**

B= unstandardized coefficient, OR= Odds ratio, 95%CI= 95% Confidence Interval. Bold values represent statistically significant association. † Multivariate regression analysis adjusted for: child's age, child's gender, child's ethnicity and child's BMI.

Table 5 Associations between possible mediating variables and children's fruit, vegetable and breakfast consumption

Fruit consumption (N=1269)	*Multivariate regression analyses* †	
	B (95%CI)	*P-value*
Parental fruit consumption	**0.34 (0.30 – 0.39)**	**0.00**
Rules about fruit consumption		
No (ref. group)	0.55	
Yes	**0.49 (0.42 – 0.56)**	**0.00**
Home availability of fruit		
Not always (ref. group)	0.42	
Always	**0.48 (0.36 – 0.60)**	**0.00**
Vegetable consumption (N=1265)	*Multivariate regression analyses* †	
	B (95%CI)	*P-value*
Parental vegetable consumption	**0.46 (0.42 – 0.47)**	**0.00**
Rules about vegetable consumption		
No (ref. group)	63.93	
Yes	**24.94 (15.20 – 34.68)**	**0.00**
Home availability of vegetables		
Not always (ref. group)	67.66	
Always	**18.62 (9.72 – 27.51)**	**0.00**
Breakfast consumption (N=1270)	*Multivariate regression analyses* †	
	OR(95% CI)	*P-value*
Parental breakfast consumption		
Not daily (ref. group)	1.00	
Daily	**15.75 (9.04 – 27.44)**	**0.00**

B= unstandardized coefficient, OR= Odds ratio, 95%CI= 95% Confidence Interval. Bold values represent statistically significant association. † Multivariate regression analysis adjusted for: child's SES, child's age, child's gender, child's ethnicity and child's BMI.

Table 6 Mediation analyses

Fruit consumption (N=1269)	*Direct association between SES and children's fruit consumption*	*Mediation models B (95 % CI)*	*P-value*	*Percentage change*	*P-value*
SES	*B*	*Model A*			
Low (ref. group)	0.84	0.54			
Intermediate	0.04	0.01 (-0.07 – 0.09)	0.84	-79.49	0.36
High	0.13	0.04 (-0.09 – 0.17)	0.32	**-66.01**	**0.02**
SES		*Model B*			
Low (ref. group)	0.84	0.55			
Intermediate	0.04	0.02 (-0.06 – 0.10)	0.58	-42.16	0.42
High	0.13	0.08 (-0.01 – 0.16)	0.09	**-40.85**	**0.00**
SES		*Model C*			
Low (ref. group)	0.84	0.42			
Intermediate	0.04	0.02 (-0.07 – 0.10)	0.69	-56.10	0.40
High	0.13	**0.10 (0.01 – 0.19)**	**0.03**	**-23.15**	**0.02**
SES		*Model D*			
Low (ref. group)	0.84	0.23			
Intermediate	0.04	-0.01 (-0.08 – 0.07)	1.12	-114.44	0.40
High	0.13	0.01 (-0.07 – 0.10)	0.75	**-89.53**	**0.00**

Vegetable consumption (N=1265)	*Direct association between SES and children's vegetable consumption*	*Mediation models B (95%CI)*[†]	*P-value*	*Percentage change*	*P-value*
SES	*B*	*Model E*			
Low (ref. group)	83.89	17.91			
Intermediate	8.33	3.19 (-3.66 – 10.05)	0.36	-61.70	0.14
High	23.81	10.44 (2.97 – 17.93)	**0.01**	**-56.13**	**0.00**
SES		*Model F*			
Low (ref. group)	83.89	63.93			
Intermediate	8.33	6.75 (-1.42 – 14.92)	0.11	-19.02	0.08
High	23.81	**21.47 (12.63 – 30.31)**	**0.00**	**-9.85**	**0.00**
SES		*Model G*			
Low (ref. group)	83.89	67.66			
Intermediate	8.33	7.39 (-0.26 – 16.12)	0.06	-4.88	0.56
High	23.81	**22.39 (13.55 – 31.23)**	**0.00**	**-5.98**	**0.00**
SES		Model H			
Low (ref. group)	83.89	10.57			
Intermediate	8.33	2.75 (-4.11 – 9.61)	0.04	-66.79	0.06
High	23.81	**9.77 (2.27 – 17.27)**	**0.011**	**-58.89**	**0.00**

Breakfast consumption (N=1270)	*Direct association between SES and children's breakfast consumption*	*Mediation model OR (95%CI)*[†]	*P-value*	*Percentage change*	*P-value*
SES	OR	*Model I*			
Low (ref. group)	1.00				
Intermediate	1.39	0.99 (0.52 – 1.90)	0.97	- 102.73	0.32
High	2.97	1.63 (0.71 – 3.67)	0.25	**-67.89**	**0.01**

SES= socioeconomic status; B= unstandardized coefficient, OR= Odds ratio, 95%CI= 95% Confidence Interval. Bold values represent statistically significant association
Model A: Single mediator model. This model includes the mediator 'parental fruit consumption'.
Model B: Single mediator model. This model includes the mediator 'parental rules regarding fruit consumption'.
Model C: Single mediator model. This model includes the mediator 'home availability of fruit'.
Model D: Multiple mediation model. This model includes the mediators: parental fruit consumption, parental rules regarding fruit consumption and home availability of fruit.
Model E: Single mediator model. This model includes the mediator 'parental vegetable intake'.
Model F: Single mediator model. This model includes the mediator 'parental rules regarding vegetable consumption'.
Model G: Single mediator model. This model includes the mediator 'home availability of vegetables'.
Model H: Multiple mediator model. This model includes the mediators: parental vegetable consumption, parental rules regarding vegetable consumption and home availability of vegetables.
Model I: Single mediator model. This model includes the mediator 'parental breakfast consumption'.
All models are adjusted for: child's age, child's gender, child's ethnicity and child's BMI

Discussion

The first aim of this study was to examine the association between SES and children's fruit, vegetable and breakfast consumption. We found that children with a high SES consumed more fruit and vegetables and consumed more often breakfast on a daily basis, than children with a low SES. These findings are in line with those from the majority of similar studies [9, 13–15, 17, 19, 35] and emphasise that children from low socio- economic groups can be considered an important target for interventions to improve dietary behaviour.

However, maternal education level, (and other measures of SES), are not considered to have a direct effect on dietary behaviour and are not easily modifiable. To explain socio-economic disparities in children's dietary behaviour, several studies examined socio-economic differences in the home food environment of children. These studies showed that the home food environment of children of mothers with a low educational level was less supportive than the home food environment of children of mothers with a high educational level [36, 37]. For example, adolescents of mothers with a low educational level were more likely to report that unhealthy foods were always or usually available at home, while adolescents of mothers with a high educational level were more likely to report that fruit was always or usually available at home and that vegetables were always served at dinner time [38]. In addition, a study among 5-6 year old children found comparable results; households of mothers with a low educational level were more likely to watch television while eating dinner and mothers with a low educational level were more likely to have negative perceptions about the quality and variety of fresh fruit and vegetables at their local shops [39]. Furthermore, Hupkens *et al*. found that mothers with a high educational level more often limited their children's intake of unhealthy foods (e.g. sweets, soft drinks, chips). These differences in the number of restricted foods by educational level were partly explained in health and

taste considerations between mothers with a low and high educational level [40]. A more recent study also found socio-economic differences in food parenting practices; frequent consumption of fruit and vegetables, restrictive rules, verbal praise, negotiation and restrain from negative modelling were all more common among mothers with a high educational level [41]. The present study also shows that aspects of the home food environment differed by SES, where low SES had the less supportive home environment.

However, socio-economic differences in determinants of the home food environment do not necessarily account for socio-economic differences in children's dietary behaviour. Therefore, a second aim of this study was to investigate modifiable factors of the home food environment that mediate the association between SES and children's fruit, vegetable and breakfast consumption. We included parental intake, home availability and parental rules about children's fruit and vegetable consumption as possible mediating variables in the association between SES and children's fruit and vegetable intake. Our results indicate that all the studied home environmental factors mediate the association between SES and children's fruit and vegetable intake. Moreover, our results indicate that the difference in fruit and vegetable consumption between children with a low and high SES is explained in particular by parental intake of fruit and vegetables. Very few studies have assessed mediators of the association between socio-economic status and children's fruit and vegetables intake. Vereecken *et al*. found that differences in children's fruit and vegetable consumption by mother's educational level were completely explained by mother's consumption and parenting practices [41]. Bere *et al*. concluded that home accessibility was the strongest mediator of the association between maternal educational level and adolescent's fruit and vegetable consumption [13]. Furthermore, Hilsen *et al*. also found that accessibility of fruit and vegetables mediates part of the association between socio-economic status and adolescent's fruit and vegetable intake [17]. In addition, they found that accessibility of fruit and vegetables explains part of the increase in SES disparities in fruit and vegetable consumption between 2001 and 2008.

To our knowledge, ours is the first study to assess possible explanatory variables of socio-economic disparities in children's breakfast consumption. We found that the difference in breakfast consumption between high SES children and low SES children was mediated by parental breakfast consumption. However, we included only one possible mediator in our analyses (parental breakfast consumption), while other potentially mediating variables were not included. For example, parenting practices are associated with children's breakfast consumption and may also be an explanatory variable of socio-economic differences in children's breakfast consumption.

It is known that aspects of the home environment are associated with children's dietary behaviour. This study indicates that home environmental factors also play a role in the explanation of socio-economic disparities in children's healthy eating behaviour. Given that parental intake was the strongest mediator and that parents shape the home food environment (e.g. they decide which food is available at home and can set food rules), parents play an important role in the development of children's dietary behaviour. Therefore, parents can be important targets for interventions. Moreover, it is necessary to reach parents with a low SES and to increase their own consumption of fruit, vegetables and breakfast, to increase the home availability of healthy products and to set food rules for their children. Campbell *et al.* found that maternal nutrition knowledge was associated with children's fruit and vegetable consumption and also with the home availability of fruit and vegetables [42]. Therefore, targeting parental nutritional knowledge (especially among those with a low educational level) may be an effective way to improve the home food environment. Besides interventions that aim at the importance of family involvement, also multiple-setting interventions are effective in changing children's dietary behaviour. In the latter case, children receive the messages in more than one setting (e.g. at home, school, and the sports club) thereby increasing the chance that such an intervention will be more effective than a single-setting approach [43]. However, interventions aiming to improve children's dietary behaviour, such as children's fruit and vegetable consumption are also necessary for children from higher socio-economic backgrounds since the majority of all children (including children of higher educational background) does not consume the recommended amount of fruit and vegetables.

The present study has some limitations. First, this study has a cross-sectional design, which does not allow to draw conclusions about causal relationships. However, as educational level is a consistent factor over time, it is highly unlikely that children's food consumption will affect a mother's educational level. Although it is possible that children's fruit and vegetable consumption contributes to the amount of fruit and vegetables available at home, or to parental consumption rules regarding fruit and vegetables, we believe that the impact of the home availability and the consumption rules of fruit and vegetables on children's fruit and vegetable intake are larger. Therefore, we expect the directions of the associations we found to be as presented in Figure 1. Second, assessments of child's fruit, vegetable and breakfast consumption were based on parent's reports instead of child reports. Child reports might be more valid, although this remains unclear. Nevertheless, Tak *et al.* [44] concluded that parents' reports could be considered as a valid method to measure children's fruit and vegetable consumption, although the use of parent's reports may evoke socially desirable answers. Finally, we measured breakfast frequency and not breakfast quality, which is associated with the nutrient adequacy of diets [45].

Conclusion

This study shows that children of mothers with low educational level have less healthy eating habits than children of mothers with a high educational level. Our study adds to the knowledge on possible mechanisms underlying socio-economic differences in healthy eating behaviour of children. Parent's food intake, home availability of healthy foods and parental rules about children's fruit and vegetable intake mediated the association between maternal educational level and children's healthy eating behaviour. Interventions to improve children's dietary behaviour and to reduce socio-economic disparities in children's eating habits, may benefit by focusing on the role of parents in the development of children's dietary behaviour.

References

1. Johnsen SP: **Intake of fruit and vegetables and risk of stroke: an overview.** *Curr Opin Clin Nutr Metab Care* 2004, **7**:665–70.
2. Cancer Research Fund/ American Institute for Cancer: *Food, Nutrition, Physical Activity and the Prevention of Cancer: A Global Perspective*. DC:AICR; 2007.
3. Hoyland A, Dye L, Lawton CL: **A systematic review of the effect of breakfast on the cognitive performance of children and adolescents.** *Nutr Res Rev* 2009, **22**:220–243.
4. Szajewska H, Ruszczynski M: **Systematic review demonstrating that breakfast consumption influences body weight outcomes in children and adolescents in Europe.** *Crit Rev Food Sci Nutr* 2010, **50**:113–119.
5. Diethelm K, Jankovic N, Moreno L a, Huybrechts I, De Henauw S, De Vriendt T, González-Gross M, Leclercq C, Gottrand F, Gilbert CC, Dallongeville J, Cuenca-Garcia M, Manios Y, Kafatos A, Plada M, Kersting M: **Food intake of European adolescents in the light of different food-based dietary guidelines: results of the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Study.** *Public Health Nutr* 2012, **15**:386–98.
6. Huybrechts I, Matthys C, Vereecken C, Maes L, Temme EH, Van Oyen H, De Backer G, De Henauw S: **Food Intakes by Preschool Children in Flanders Compared with Dietary Guidelines**. *Int J Environ Res Public Health* 2008, **5**:243–257.
7. Ocké MC: **Dutch National Food Consumption Survey – Young Children 2005 / 2006**. *Public Health* 2007.
8. Van Ansem WJ, Schrijvers CT, Rodenburg G, van de Mheen D: **Is there an association between the home food environment, the local food shopping environment and children's fruit and vegetable intake? Results from the Dutch INPACT study.** *Public Health Nutr* 2012:1–9.
9. Vereecken C, Dupuy M, Rasmussen M, Kelly C, Nansel TR, Al Sabbah H, Baldassari D, Jordan MD, Maes L, Niclasen BV-L, Ahluwalia N: **Breakfast consumption and its socio-demographic and lifestyle correlates in schoolchildren in 41 countries participating in the HBSC study.** *Int J Public Health* 2009, **54 Suppl 2**:180–90.
10. Rampersaud GC, Pereira MA, Girard BL, Adams J, Metzl JD: **Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents.** *J Am Diet Assoc* 2005, **105**:743–60; quiz 761–2.
11. Kelder SH, Perry CL, Klepp KI, Lytle LL: **Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors.** *Am J Public Health* 1994, **84**:1121–6.
12. Craigie AM, Lake A a., Kelly S a., Adamson AJ, Mathers JC: **Tracking of obesity-related behaviours from childhood to adulthood: A systematic review.** *Maturitas* 2011, **70**:266–84.
13. Bere E, van Lenthe F, Klepp K-I, Brug J: **Why do parents' education level and income affect the amount of fruits and vegetables adolescents eat?** *Eur J Public Health* 2008, **18**:611–5.
14. Riediger ND, Shooshtari S, Moghadasian MH: **The influence of sociodemographic factors on patterns of fruit and vegetable consumption in Canadian adolescents.** *J Am Diet Assoc* 2007, **107**:1511–8.
15. Hanson MD, Chen E: **Socioeconomic status and health behaviors in adolescence: a review of the literature.** *J Behav Med* 2007, **30**:263–85.
16. Rasmussen M, Krølner R, Klepp K-I, Lytle L, Brug J, Bere E, Due P: **Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies.** *Int J Behav Nutr Phys Act* 2006, **3**:22.
17. Hilsen M, van Stralen MM, Klepp K-I, Bere E: **Changes in 10-12 year old's fruit and vegetable intake in Norway from 2001 to 2008 in relation to gender and socioeconomic status - a comparison of two cross-sectional groups.** *Int J Behav Nutr Phys Act* 2011, **8**:108.
18. Pearson N, Biddle SJH, Gorely T: **Family correlates of breakfast consumption among children and adolescents. A systematic review.** *Appetite* 2009, **52**:1–7.
19. Hallström L, Vereecken C, Ruiz JR, Patterson E, Gilbert CC, Catasta G, Díaz L-E, Gómez-Martínez S, González Gross M, Gottrand F, Hegyi A, Lehoux C, Mouratidou T, Widham K, Aström A, Moreno LA, Sjöström M: **Breakfast habits and factors influencing food choices at breakfast in relation to socio-demographic and family factors among European adolescents. The HELENA Study.** *Appetite* 2011, **56**:649–657.
20. Hallström L, Vereecken CA, Labayen I, Ruiz JR, Le Donne C, García MC, Gilbert CC, Martínez SG, Grammatikaki E, Huybrechts I, Kafatos A, Kersting M, Manios Y, Molnár D, Patterson E, Widhalm K, De Vriendt T, Moreno LA, Sjöström M: **Breakfast habits among European adolescents and their association with sociodemographic factors: the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study.** *Public Health Nutr* 2012, **15**:1879–1889.
21. Tinsley B: *How Children Learn to Be Healthy*. Cambridge University Press; 2003.
22. Lindsay AC, Sussner KM, Kim J, Gortmaker S: **The role of parents in preventing childhood obesity.** *Future Child* 2006, **16**:169–86.
23. Krølner R, Rasmussen M, Brug J, Klepp K-I, Wind M, Due P: **Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part II: qualitative studies.** *Int J Behav Nutr Phys Act* 2011, **8**:112.
24. Pearson N, Biddle SJH, Gorely T: **Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review.** *Public Health Nutr* 2009, **12**:267–83.
25. Winkleby MA, Jatulis DE, Frank E, Fortmann SP: **Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease.** *Am J Public Health* 1992, **82**:816–820.
26. Bogers RP, Van Assema P, Kester ADM, Westerterp KR, Dagnelie PC: **Reproducibility, validity, and responsiveness to change of a short questionnaire for measuring fruit and vegetable intake.** *Am J Epidemiol* 2004, **159**:900–9.
27. Haraldsdóttir J, Thórsdóttir I, de Almeida MDV, Maes L, Pérez Rodrigo C, Elmadfa I, Frost Andersen L: **Validity and reproducibility of a precoded questionnaire to assess fruit and vegetable intake in European 11- to 12-year-old schoolchildren.** *Ann Nutr Metab* 2005, **49**:221–7.
28. Dutman AE, Stafleu A, Kruizinga A, Brants HAM, Westerterp KR, Kistemaker C, Meuling WJA, Goldbohm RA: **Validation of an FFQ and options for data processing using the doubly labelled water method in children.** *Public Health Nutr* 2011, **14**:410–7.
29. Brants H, Stafleu A, Ter Doest D, Hulshof K: **Ontwikkeling van een voedselfrequentievragenlijst: energie-inneming van kinderen van 2 tot en met 12 jaar.** *Voeding Nu* 2006, **2**:25–28.
30. The Netherlands Nutrition Centre Foundation: *Richtlijnen Voedselkeuze (Dietary Guidelines).* The Hague; 2011.
31. Van der Horst K, Oenema A, van de Looij-Jansen P, Brug J: **The ENDORSE study: research into environmental determinants of obesity related behaviors in Rotterdam schoolchildren.** *BMC Public Health* 2008, **8**:142.

32. Gattshall ML, Shoup JA, Marshall JA, Crane LA, Estabrooks PA: **Validation of a survey instrument to assess home environments for physical activity and healthy eating in overweight children.** *Int J Behav Nutr Phys Act* 2008, **5**:3.
33. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH: **Establishing a standard definition for child overweight and obesity worldwide: international survey.** *BMJ* 2000, **320**:1240–3.
34. Baron RM, Kenny DA: **The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations.** *J Pers Soc Psychol* 1986, **51**:1173–82.
35. Johansen A, Rasmussen S, Madsen M: **Health behaviour among adolescents in Denmark: influence of school class and individual risk factors.** *Scand J Public Health* 2006, **34**:32–40.
36. Sandvik C, Gjestad R, Samdal O, Brug J, Klepp K-I: **Does socio-economic status moderate the associations between psychosocial predictors and fruit intake in schoolchildren? The Pro Children study.** *Health Educ Res* 2010, **25**:121–34.
37. Neumark-Sztainer D, Wall M, Perry C, Story M: **Correlates of fruit and vegetable intake among adolescents**. *Prev Med (Baltim)* 2003, **37**:198–208.
38. MacFarlane A, Crawford D, Ball K, Savige G, Worsley A: **Adolescent home food environments and socioeconomic position.** *Asia Pac J Clin Nutr* 2007, **16**:748–756.
39. Campbell K, Crawford D, Jackson M, Cashel K, Worsley A, Gibbons K, Birch LL: **Family food environments of 5-6-year-old-children: does socioeconomic status make a difference?** *Asia Pac J Clin Nutr* 2002, **11 Suppl 3**:S553–61.
40. Hupkens CL, Knibbe RA, Van Otterloo AH, Drop MJ: **Class differences in the food rules mothers impose on their children: a cross-national study.** *Soc Sci Med* 1998, **47**:1331–1339.
41. Vereecken C, Keukelier E, Maes L: **Influence of mother's educational level on food parenting practices and food habits of young children.** *Appetite* 2004, **43**:93–103.
42. Campbell KJ, Abbott G, Spence AC, Crawford DA, McNaughton SA, Ball K: **Home food availability mediates associations between mothers' nutrition knowledge and child diet.** *Appetite* 2013, **71**:1–6.
43. Hendrie GA, Brindal E, Corsini N, Gardner C, Baird D, Golley RK: **Combined home and school obesity prevention interventions for children: what behavior change strategies and intervention characteristics are associated with effectiveness?** *Health Educ Behav* 2012, **39**:159–71.
44. Tak NI, te Velde SJ, de Vries JHM, Brug J: **Parent and child reports of fruit and vegetable intakes and related family environmental factors show low levels of agreement.** *J Hum Nutr Diet* 2006, **19**:275–285.
45. Matthys C, De Henauw S, Bellemans M, De Maeyer M, De Backer G: **Breakfast habits affect overall nutrient profiles in adolescents.** *Public Health Nutr* 2007, **10**:413–21.

chapter 6

inequalities

Socio-economic inequalities in children's snack consumption and sugar-sweetened beverage consumption: the contribution of home environmental factors

Socio-economic inequalities in children's snack consumption and sugar-sweetened beverage consumption: the contribution of home environmental factors

Wilke J.C. van Ansem, Frank J. van Lenthe, Carola T.M. Schrijvers, Gerda Rodenburg, Dike van de Mheen
British Journal of Nutrition, 2014, 112 (3),467-76

Abstract

In 11-year-old children we examined the association between maternal education and unhealthy eating behaviour (the consumption of snack and sugar-sweetened beverages (SSB)), and explored environmental factors that might mediate these associations. These environmental factors include home availability of snacks and SSBs, parental rules about snack and SSB consumption, parental intake of snacks and SSBs, peer sensitivity, and children's snack-purchasing behaviour. Data were obtained from the fourth wave of the INPACT-study (2011), in which 1318 parent-child dyads completed a questionnaire. Data were analysed with multivariate regression models. Children of mothers with an intermediate educational level consumed more snacks than those of mothers with a high educational level (B=1.22, P=0.02). This association was not mediated by environmental factors. Children of mothers with a low educational level consumed more SSB than those of mothers with a high educational level (B=0.63, P=<0.01). The association between maternal educational level and children's SSB intake was mediated by parental intake and home availability of SSB. The home environment seems a promising setting for interventions on reducing socio-economic inequalities in children's SSB consumption.

Introduction

Childhood overweight and obesity are major health issues in many countries, not only because of their high prevalence rates, but also because overweight and obesity are related to several negative health outcomes in childhood and adulthood.[1–4] One factor contributing to the rising prevalence of overweight and obesity in children and adolescents is their high consumption of sugar-sweetened beverages (SSB) and energy-dense snacks:[5] a US study found that 84% of adolescents consume an average of 887 ml (30 oz) SSB every day – equivalent to 16% of their total energy intake.[6] European studies in the Netherlands, Hungary and Belgium reported mean daily intakes of 350 ml for girls and 500 ml for boys, and a high consumption of soft drinks (more than 450 ml a day) [7, 8]. With regard to the consumption of energy-dense snacks, children in the USA were reported to consume nearly three snacks per day, with snacking accounting for up to 27% of daily caloric intake.[9] As children's and adolescents' dietary habits track into adulthood, [10, 11] it is important to establish healthy eating habits at an early age. However, to develop effective interventions for reducing the consumption of energy-dense snacks and SSBs, it is first necessary to understand the factors that influence children's dietary behaviour.

In recent years, research on children's dietary behaviour has focused more on environmental determinants. The environment has been defined as 'everything outside the individual', which had been structured in a framework for obesity-related research in the ANGELO (Analysing Grid for Environments Linked to Obesity) model [12]. Following this model, environments can be divided into two levels (micro and macro level) and four types (socio-cultural, economic, political, and physical). Regarding the levels, the influence of children's environment is largely confined by their micro-environment, such as the home environment and the neighbourhood environment. For children, especially young ones, the home food environment is an important influence on the development of their dietary behaviour[13]: parents determine which food is available at home, can set rules on what their children are allowed to eat, and can act as role models, also with respect to dietary behaviour[14]. It was found by studies investigating the associations between aspects of the home food environment and children's snack and SSB intake that children's consumption was influenced by the home availability of SSB and energy-dense snacks, by parents' own intake of them, and by family food rules regarding snacks and SSB [13, 15–19].

In most western countries, children in the transition from childhood to adolescence (10-12 years) now have considerable autonomy and decision-making power in their dietary behaviour [13, 20]. They spend a lot of time with their friends and get pocket money they may use to purchase unhealthy foods. It is therefore likely that dietary behaviour in this age group is determined not only by the home food environment, but also by children's food-purchasing behaviour and their peers' dietary behaviour. While there has been little research on peers' influence on children's energy-dense snack and SSB consumption, peer-group snack and soft drink consumption was found to be associated with the intake of SSBs and snacks among adolescents aged 12-17. [21] Previous findings in the INPACT study also showed that children who were sensitive to peer influence consumed more snacks than their counterparts who were not sensitive to it [22]. Similarly, a recent review by Fletcher et al (2011) concluded that school friendships may be critical in shaping adolescents' eating behaviours [23].

While little is known about the role of economic factors in children's dietary behaviour, it is generally assumed that parents make decisions that can be influenced by economic determinants, although they leave some of these decisions to their children.[24] For instance, parents provide pocket money for children to spend on items of their own choice. In the Netherlands, 82% of children aged 6-7 years receive pocket money [25]. Those with access to pocket money spent more on sweets and snacks [20, 26]. Children who purchased snacks or sweets from their pocket money also consumed more energy-dense snacks than counterparts who did not [22]. It was also found that children who received pocket money consumed more soft drinks [24].

Several studies have found associations between socio-economic status (SES) and children's dietary behaviour, low SES being associated with unhealthy dietary patterns (snacks and fast food) in children and adolescents [27, 28]. Children and adolescents with a lower SES consumed more soft drinks and were more likely to be overweight than their counterparts with high SES [29–31]. However, because SES is not an easily modifiable correlate of children's dietary behaviour and does not directly influence dietary behaviour, it is important to identify modifiable determinants of children's unhealthy dietary behaviour that may explain socio-economic inequalities in their energy-dense snack and SSB consumption. However, little literature is available on factors that explain socio-economic disparities in children's energy-dense snack and SSB consumption.

The overall aim of this study was therefore to explore the extent to which various types of environmental factor explain socio-economic inequalities in 10 to 12-year-olds' consumption of SSBs and energy-dense snacks. We examined: 1) the association between SES (maternal educational level) and children's SSB and energy-dense snack consumption; 2) whether the association between SES and children's energy-dense snack consumption is mediated by home environmental factors (home availability, food rules, and parental intake); by economic factors (children's food purchasing behaviour), or by peer sensitivity; and 3) whether the association between SES and children's SSB consumption is mediated by home environmental factors (home availability, food rules and parental intake) (Figure 1). Because no proper data were available on SSB purchasing behaviour and peer sensitivity regarding SSB consumption, we were unable to explore their contribution to socio-economic inequalities in children's SSB consumption.

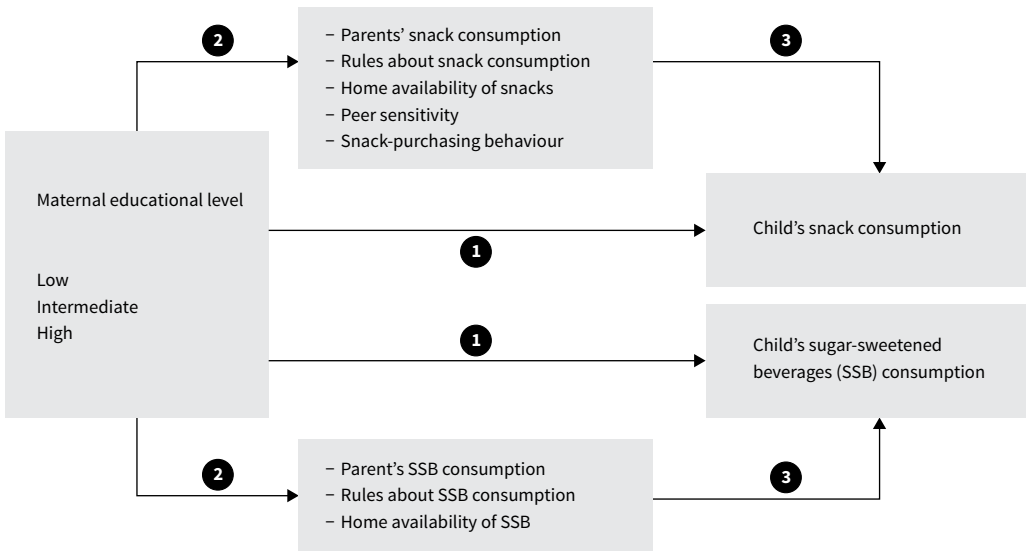

Figure 1 Research model

Methods

Study population and design

The data used in this study are derived from the Dutch INPACT study. INPACT is the acronym for IVO Physical Activity Child cohorT, a longitudinal study among 8 to12-year-olds and their parents to investigate modifiable environmental determinants of children's dietary behaviour and physical activity. The INPACT study had four annual data-collection periods (2008 – 2011). Participants were recruited through primary schools in the southern part of the Netherlands (Eindhoven and surroundings). The municipal health service invited all primary schools in this area to participate in this study (n=265). Ninety one primary schools (n=34.3%) agreed. The response by schools in urban and rural areas was similar. A total of 1844 parent-child dyads (62.5%) gave informed consent. Trained research assistants visited the participating schools and measured children's height and weight. Children completed a short questionnaire at school, and parents completed a questionnaire at home. The questionnaire topics differed annually. The INPACT study was approved by the Medical Ethical Committee at Erasmus University Medical Centre Rotterdam. The present study was based on the data collected in the last wave (2011), in which a questionnaire was completed by 1428 parents (77.5%) and 1575 children (85.4%).

Measurements

Maternal educational level

In this study we used maternal educational level as an indicator of SES, as it is one of the three commonest indicators of SES, and was found to be the strongest and most consistent SES indicator for predicting health-related behaviour.[32] Maternal educational level was classified into three groups: 'low educational level' (primary school and lower secondary education); 'intermediate educational level' (intermediate vocational level, higher secondary school, and pre-university education); and 'high educational level' (higher vocational education and university). Throughout the remainder of this paper we thus refer to 'low SES' (children of mothers with a low educational level), 'intermediate SES' (children of mothers with an intermediate educational level) and 'high SES' (children of mothers with a high educational level).

Outcome measurements (children's snack and SSB consumption)

To measure a child's snack and SSB consumption, we used questionnaires based on the validated Food Frequency Questionnaire. [33, 34] Children's snack consumption was based on child's reports, and their SSB intake was based on parental reports (no child reports were available on SSB intake). It was reported how many days in the past seven days children had consumed the following items between meals: 1) savoury snacks (e.g. potato chips, peanuts, or sausage rolls); 2) sweet snacks (e.g. candy bars, chocolate, or candies); and 3) cake or large biscuits; and 4) SSBs. Answering categories ranged from 'none or less than one day a week' to 'seven days a week'. Additionally, the number of items children consumed on such a day was reported. For savoury snacks, sweet snacks and cake or large biscuits, the answering categories ranged from '0 items per day' to '10 items or more per day'. For SSBs, the answering categories ranged from '0 glasses per day' to 'more than 5 glasses per day', by increments of half a glass. A reported consumption of more than 5 glasses per week (n=7) was recoded as 6 glasses. In the questionnaire it was specified that one glass equals 200 ml, that one can equals 330 ml or 1.5 glasses, and that one bottle equals 500 ml or 2.5 glasses. Children's total snack consumption was calculated in items per week by multiplying the consumption frequencies of savoury snacks, sweet snacks and cakes with their corresponding quantities and summing these scores. Children's SSB consumption was calculated in servings per week by multiplying frequencies and quantity.

Potential mediating variable

Parental intake of snacks and SSB

Parental snack and SSB consumption were measured and calculated in the same way as children's snack and SSB consumption; it was reported by the parents.

Snack and SSB consumption rules

Parents were asked if they had rules about 1) the number of snacks and 2) the number of SSB their children were allowed to consume. Response categories were 'yes' and 'no'. These questions were derived from the Endorse study [35].

Home availability of snacks and SSBs

The availability of snacks and SBBs at home was measured using a questionnaire based on the validated Home Environment Survey.[36] Parents were asked to report how often 1) sweet snacks and biscuits, 2) savoury snacks and 3) SBBs were available at home. Response categories were 'always available', 'usually available', 'sometimes available', 'usually not available' and 'never available'. Due to limited variation in this variable, we dichotomised the response categories into 'always available' and 'not always available'. We created one variable for the home availability of snacks, for which we merged the home availability of sweet snacks and savoury snacks into one variable. Due to limited variation in these variables we dichotomised the response categories into: 'snacks always available at home' (at least sweet snacks and biscuits or savoury snacks were always available at home) versus 'snacks not always available at home' (neither sweet snacks and biscuits nor savoury snacks were always available at home).

Snack-purchasing behaviour

Children were asked what they usually bought with their pocket money. There were ten answering categories including 'sweet snacks' and 'savoury snacks'; most of the other categories were non-food items (e.g. 'toys', 'computer games' or 'books'). Children were allowed to report more than one answering category. We created a dichotomous variable 'purchasing snacks' with answering category 'yes' (children bought sweet snacks and/or savoury snacks), and 'no'. Children who did not receive pocket money (n=267, 18.7%) were classified as 'purchasing no snacks'.

Peer sensitivity

To measure the influence of peers on children's dietary intake, we presented the children the following hypothetical situation: *'After school, you are with some friends. You and your friends decide to go to a supermarket or fast-food restaurant. While you don't intend to buy any snacks, you decide to join your friends. When they're in the supermarket or fast food restaurant, all your fiends buy snacks.'* We asked the children how they would act in such a situation. Two options were available: 'Then I'll buy some food, too' or 'I won't buy any food'. We named the answering categories as 'peer sensitivity' ('Then I'll buy some food, too') and 'peer sensitivity' ('I won't buy any food').

Control variables

Because they might be associated with the dependent and independent variables, a child's age, gender, ethnicity and BMI were considered as potential confounders.

A child's age was calculated on the basis of the date of birth and the date of measurement. For the purpose of analysis we dichotomised child's age into '≤11 years' versus '>11 years'. Children's ethnicity was categorised into 'Dutch native' (both parents born in the Netherlands) and 'immigrants' (at least one of the parents was born outside the Netherlands). Children's BMI was calculated on the basis of their weight and height, which were measured with clothes but without shoes to the nearest 0.1 kg and 0.1 cm; the measurements were made by trained research assistants. BMI cut-off points for children were used to define 'overweight' ('overweight' and 'obesity') versus 'non overweight' ('underweight and normal weight').[37]

Data analysis

Respondents who lacked data for maternal educational level were excluded from the analysis (n=110, 7.7%). Descriptive analyses were performed to describe the characteristics of the study population. To investigate whether environmental factors mediated the association between maternal educational level and children's consumption of energy-dense snacks and SSB, we used Baron and Kenny's four-step approach.[38] According to Baron and Kenny, there are three criteria for mediation: 1) the predictive variable has to be associated with the outcome variable, 2) the predictive variable has to be associated with the mediator, and 3) the mediator has to be associated with the outcome variable (adjusted for the predictive variable). If all the associations assessed in steps 1-3 are statistically significant, the criteria for mediation have been met. Step four of the approach is to test the mediation model: mediation is supported if the association between the predictive variable and the outcome variable changes after control for the mediator [38].

The steps of the mediation-analyses were conducted separately for each outcome measure (child snack consumption and child SSB consumption). Depending on the scale of the outcome measures, logistic regression models or linear regression models were used to test the subsequent steps of the mediation approach. Several potential mediators were tested for each outcome measure. If it appeared that more than one potential mediator met the criteria for mediation, the unique contribution of each mediator was determined (single mediator model). Next, a multivariate mediation model was tested. Bootstrap resampling techniques were used to calculate confidence intervals for the mediated effects.

All analyses were adjusted for the potential confounders. The regression analyses were performed using IBM SPSS Statistics version 20, and the bootstrapping analysis were performed using R (2013). Due to missing values, the computed models for snack and SSB consumption differ with regard to the numbers of participants.

Results

Most children were 11 years or younger; about half were boys. The majority were Dutch natives and were not overweight (table 1). There were statistically significant SES differences in their background characteristics: 1) relative to the low SES and high SES groups, there were more girls in the intermediate SES group; and 2) relative to children with an intermediate or high SES, more children with a low SES were overweight, were older than 11 years, and were immigrants.

Table 1 Characteristics of the study population: total sample and sample broken down according by maternal educational level

	Total sample	Low educational level	Intermediate educational level	High educational level	P-value
Mean age N (%)	N=1317	N=263	N=628	N=426	**0.00**
≤11 years	1119 (85.0)	205 (77.9)	528 (84.1)	386 (90.6)	
> 11 years	198 (15.0)	58 (22.1)	100 (15.9)	40 (9.4)	
Gender %	N=1318	N=263	N=629	N=426	**0.02**
Boys	50.8	52.5	46.7	55.6	
Girls	49.2	47.5	53.3	44.4	
Child's BMI %	N=1283	N=252	N=616	N=415	**0.01**
Overweight	11.2	16.7	10.6	8.9	
No overweight	88.8	83.3	89.4	91.9	
Child's ethnicity %	N=1318	N=263	N=629	N=426	**0.02**
Native Dutch	88.8	84.4	90.9	89.4	
Immigrant	11.2	15.6	9.1	10.6	

Snack consumption

While high SES children had the lowest mean snack consumption (9.0 items a week), those with an intermediate SES had the highest (10.2 items) (univariate analyses) (Table 2). Multivariate analyses showed that, per week, children with an intermediate SES consumed 1.22 snack items more than those with a high SES (95% CI: 0.22 – 2.20). There was no statistically significant difference in snack consumption between children with a low SES and those with a high SES. Because none of the potential mediators was associated with maternal educational level, the criteria for mediation were not met, and the further steps of the mediation analysis were not conducted.

Table 2 Regression analyses of snack consumption (n= 906)

Step 1: Association between maternal educational level and child's snack consumption	**Children's mean intake of snacks (items per week) by maternal educational level (unadjusted)**	**Multivariate regression analyses*** B (95%CI)
Maternal educational level		
High	9.0	9.22
Intermediate	10.2	**1.22 (0.22 – 2.20)**
Low	9.9	0.99 (-0.26 – 2.25)
Step 2: Association between maternal educational level and potential mediating variables	**Descriptives regarding possible mediating variables by maternal educational level (unadjusted)**	**Multivariate regression analyses***
Maternal educational level	*Parents' mean snack intake (items per week)*	*B (95%CI)*
High	5.9	5.64
Intermediate	6.0	0.11 (-0.63 – 0.84)
Low	5.6	-0.21 (-1.13 – 0.72)
Maternal educational level	*Parents who have rules about snack consumption %*	*OR (95%CI)*
High	72.9	1.00
Intermediate	73.2	1.01 (0.80 – 1.73)
Low	77.0	1.18 (0.75 – 1.35)
Maternal educational level	*Always snacks available at home %*	*OR (95%CI)*
High	75.3	1.00
Intermediate	74.2	0.98 (0.72 – 1.33)
Low	75.7	1.16 (0.78 – 1.71)
Maternal educational level	*Children who are sensitive to peer influence %*	*OR (95%CI)*
High	61.1	1.00
Intermediate	60.5	0.98 (0.75 – 1.28)
Low	60.0	0.97 (0.69 – 1.36)
Maternal educational level	*Children who purchase food %*	*OR (95%CI)*
High	5.7	1.00
Intermediate	6.7	1.21 (0.70 – 2.09)
Low	6.1	1.07 (0.53 – 2.16)

B= unstandardized coefficient, OR= Odds Ratio, 95%CI= 95% Confidence interval
* Multivariate regression analyses adjusted for child's age, gender, ethnicity and BMI. Bold values represent statistically significant associations.

SSB consumption

The highest mean SSB intake was in low SES children (2.4 litre per week), and the lowest in high SES children (1.8 litre per week) (Table 3). Multivariate analysis showed that children with a low SES consumed 0.63 litre SSB more per week than high SES children (95% CI: 0.36 – 0.91). There was no statistically significant difference in SSB intake between children with an intermediate SES and those with a high SES.

Parents with an intermediate SES and parents with a low SES consumed more SSB and were more likely always to have SSB available at home than parents with a high SES. There was no statistically significant association between maternal educational level and SSB consumption rules. As this meant that the criteria for mediation were not met, the remaining steps of the mediation analyses were not performed for SSB consumption rules.

Parental intake of SSB and home availability of SSB were significantly associated with children's SSB intake: if their parents consumed 1 litre SSB per week, children consumed 0.46 litres SSB more per week. If SSB were always available at home, they consumed 0.96 litres SSB more per week.

In the single-mediator models, home availability of SSBs explained 23.7% of the socio-economic

differences between children with a low educational level and those with a high educational level; parental intake of SSBs explained 45.6%. In the multiple-mediator model, home availability and parental intake of SSBs together explained 58.2% of the differences in SSB intake between children with a low SES and those with a high SES. Home availability of SSB and parental intake of SSB did not significantly mediate the SSB intake between children with an intermediate educational level and those with a high educational level.

Table 3 Analyses SSB intake (n=1266)

Step 1: Association between maternal educational level and child's SSB consumption	**Children's mean SSB intake (litre per week) by maternal educational level (unadjusted)**	**Multivariate regression analyses* B (95%CI)**
Maternal educational level		
High	1.8	2.13
Intermediate	2.0	0.17 (-0.05 – 0.39)
Low	2.4	**0.63 (0.36 – 0.91)**
Step 2: Association between maternal educational level and potential mediating variables	**Descriptives regarding possible mediating variables by maternal educational level (unadjusted)**	**Multivariate regression analyses***
Maternal educational level	*Parents' mean SSB intake*	*B (95%CI)*
High	0.7	0.51
Intermediate	0.9	**0.24 (0.06 – 0.43)**
Low	1.3	**0.62 (0.39 – 0.85)**
Maternal educational level	*Parents who have rules about SSB consumption %*	*OR (95%CI)*
High	67.9	1.00
Intermediate	70.6	1.16 (0.88 –1.52)
Low	67.9	0.95 (0.69 – 1.37)
Maternal educational level	*Always SSB available at home %*	*OR (95%CI)*
High	59.7	1.00
Intermediate	69.0	**1.51 (1.16 – 1.97)**
Low	74.0	**2.07 (1.45 – 2.95)**
Step 3: Association between possible mediating variables SSB and children's SSB intake	**Children's mean SSB consumption by mediating variables (unadjusted)**	**Multivariate regression analyses** B (95%CI)**
Parents' SSB consumption	-	**0.46 (0.40 – 0.52)**
Home availability of SSB		
Not always	1.32	1.51
Always	2.35	**0.96 (0.77 – 1.17)**
Step 4: Mediation model	**B model step 1**	**Percentage change (95% CI)**
Maternal educational level + parents' SSB consumption		
High	2.13	
Intermediate	0.17	- 65.5 (-359.74 – 204.32)
Low	0.63	**- 45.6 (-79.68 – -25.76)**
Maternal educational level + home availability of SSB	2.13	
High	0.17	- 51.6 (-513.51 – 250.18)
Intermediate	0.63	**- 23.7** (-46.82 – -12.68)
Low		
Maternal educational level + parents' SSB consumption + home availability of SSB		
High	2.13	
Intermediate	0.17	- 96.3 (-681.20 – 301.66)
Low	0.63	**- 58.2** (-102.70 – -37.06)

B= unstandardized coefficient, OR= Odds Ratio, 95%CI= 95% Confidence interval.
* Multivariate regression analyses adjusted for child's age, gender, ethnicity and BMI. Bold values represent statistically significant associations.
** Multivariate regression analyses adjusted for maternal educational level, child's age, child's gender, child's ethnicity and child's BMI. Bold values represent statistically significant associations.

Discussion

Our results showed that children with a high SES had the lowest snack and SSB consumption, while children with an intermediate SES had the highest snack consumption and children with a low SES had the highest SSB consumption. The association between maternal educational level and children's energy-dense snack intake was not mediated by the environmental factors, because none of them differed between socioeconomic groups. The association between maternal educational level and children's SSB intake was mediated by the home availability of SSBs and parental intake of SSBs.
As stated above, we found socio-economic differences in children's energy-dense snack consumption. Unexpectedly, there was no ascending gradient in children's snack consumption, children with an intermediate SES having the highest snack consumption. Neither was there a significant difference in snack consumption between children with a high SES and those with a low SES. Both of these findings may be due to the difficulty of accurately measuring snack consumption, where the main problem is one of definition. As snacking is often defined as an eating occasion between meals, a snack can be any kind of food that is eaten between meals – for example, fruit is sometimes referred to as a healthy snack [39]. And as snacks represent a broad range of foods, their nutrient and caloric value can differ greatly between one snack and another, and therefore be hard to measure precisely.
In our study, the term 'snacks' referred to unhealthy foods eaten between meals. To measure snack consumption as accurately as possible, we distinguished three categories of energy-dense snack – savoury snacks, sweet snacks, and cake or large biscuits – and gave examples of the type of foods

we considered as snacks in each category. Nevertheless, the caloric intake from snacks remains unclear, and it is possible that children from lower SES backgrounds consumed more low-nutrient calorie-dense snacks than those from higher ones. However, our findings that children with a high SES consumed fewer snacks than children from lower SES groups were in line with previous studies [27, 28].

Contrary to our expectations, we found no association between maternal educational level and the home-environmental determinants of snacking (i.e. home availability of snacks, snack consumption rules, and parental intake of snacks). This may also have been due to the same difficulties in defining snacks, and may also affect the measurement of the home-environmental determinants of snacking. For example, it is conceivable that children from low SES backgrounds have more high-caloric snacks available at home than their counterparts in high SES backgrounds; although this was not found in our data. It is also possible that the use of dichotomised variables (e.g. home availability of snacks) may be responsible for a lack of mediation effect in the association between maternal educational level and children's snack intake. However, additional analyses (in which home availability of snacks was included as a measure with three answering categories) yielded comparable results. Nevertheless, future studies should use more extensive questionnaires to measure determinants of the home food environment instead of the use of binary variables.

Hardly any other studies have examined the association between the environmental determinants of snack consumption and socio-economic status. To our knowledge, only a study by Hupkens et al. explored whether food rules varied across maternal educational levels [40]. They found that high-SES mothers more likely to limit their children's intake of sweets and chips. However, due to differences in measurements, the results of Hupkens et al. are not comparable with our own.

We found no association between maternal educational level and children's snack-purchasing behaviour. In fact, our results showed that only a small proportion of the children purchased snacks from their pocket money. This indicates that pocket money has only a limited influence on the dietary behaviour of primary school children (aged 10-12). As Dutch primary schools have no canteens or vending machines, children also have fewer opportunities to purchase snacks. The influence of pocket money on children's dietary behaviour may be greater in older adolescents, who have more autonomy and more opportunities to buy food. By interpreting the findings regarding pocket money, we should mention that children who did not receive pocket money (n=267, 18.7%) were classified as 'purchasing no snacks". However, this possibly biased our results, as we do not know if these children would buy snacks if they received pocket money. However, additional analyses in which children who received no pocket money were excluded from the analyses yielded the same results.

Our results also showed that peer sensitivity was not associated with children's SES. Although no other studies have examined whether the association between SES and children's dietary behaviour is mediated by peer sensitivity, the influence of peers on children's dietary behaviour has been studied among older children at secondary school [21, 41, 42]. This may suggest that peers are likely to have more influence on dietary behaviour in older adolescents. Future studies could explore whether socio-economic differences in adolescent's dietary behaviour are explained by economic factors and peer sensitivity.

In the case of children's SSB consumption, we explored whether the association between maternal educational level and children's SSB consumption was mediated by home environmental factors (parental intake of SSB, SSB consumption rules, and the home availability of SSB). In line with a recent study by De Coen et al,[29] we found that parental intake and home availability were indeed mediating factors. Unlike some previous studies, however, we found no associations between SES and SSB consumption rules [29, 40].

It was already known that home environmental determinants (including children's snack and SSB consumption) are important to the development of children's dietary behaviour. Our findings showed that socio-economic disparities in children's SSB consumption are also explained by home environmental factors. Because parents shape the home food environment (by deciding, for example, which food is available, and by setting food rules) [14], they not only play a crucial role in the development of children's dietary behaviour, but are also important targets for health interventions. Interventions focusing on home environmental factors and the important role of parents may be able to reduce not only children's snack and SSB consumption but also socio-economic differences in children's SSB intake. Although improving the home food environment may be a key factor through which interventions can improve children's dietary intake, little is known about effective ways to do this. However, a few community interventions have examined changes in children's home food environments. These interventions provide activities to engage families and it was found that this may provide added benefit to improve the home food environment [43, 44].

Our study has some limitations. First, except for the data on child BMI, most of our data were parent or child reports. By evoking socially desirable answers, these may lead to underreporting of the outcome variables (child snack consumption and child SSB consumption) or of any of the potential mediating variables (home availability, rules and parental intake). If certain SES-groups give a greater number of socially desirable responses, underreporting of mediating variables can lead these variables to be underestimated as factors that explain socio-economic differences in children's snack intake. For example, because parents with a high SES are more likely to be more health-minded and to have more knowledge about healthy eating behaviour, they may also be likely to give more socially desirable responses. On the other hand, it is possible that parents and children from high socio-economic backgrounds do indeed have more healthy eating patterns in which they consume fewer snacks and SSB. This would make it less likely that they gave social desirable answers. Due to this and to our finding of associations between maternal educational level and home environmental determinants of SSB consumption, we do not expect socially desirable answers to explain why we found no associations between maternal educational level and the home environmental determinants of snacking. The second limitation is that we measured peer sensitivity on the basis of the children's answers to how they would act in a hypothetical situation; we did not measure their actual behaviour when they spent time with their friends. It may be difficult for children, especially those with a low SES, to answer questions about a hypothetical situation. However, because trained research assistants were available to help them complete the questionnaire in the classroom, we believe that this will not have affected the results substantially. The question to measure peer sensitivity was developed for this study, as to our knowledge, no relevant child questionnaires were available. Future research should develop validated questionnaires to measure the influence of peers on children's and adolescents dietary behaviour. The third limitation is that we based statistical analyses on a cross-sectional dataset that did not allow conclusions to be drawn about any causal relationships. But as educational level is a consistent factor over time, it is highly unlikely that children's food consumption will affect a mother's educational level. Although it is possible

that children's SSB consumption contributes to the amounts of SSB available at home, or to parental consumption of SSB, we believe that the impact of parental intake and the home availability of snacks and SSB on children's consumption of snacks and SSB are greater. We therefore expect the directions of the associations we found to be as presented in Figure 1. Finally, in our analyses we adjusted for some potential confounders, including child BMI. Since child BMI is associated with many other factors, there is a risk of 'overadjusting' the associations under study. Adjustment of child BMI may have erased part of the effect of SES and children's snacks and SSB consumption. However, additional analyses in which we excluded child BMI as a control variable showed comparable results.

Conclusion

This study found associations between maternal educational level and children's consumption of SSB and snacks, with children of mothers with a lower educational level (low and intermediate SES) showing the least favourable behaviour. The association between maternal educational level and children's SSB intake was mediated by parental intake of SSBs and the home availability of SSBs.
Interventions to reduce children's SSB intake, especially the intake of children from a low socio-economic background, should focus on reducing the home availability of SSB and their intake by parents. Future research should focus on ways of doing so, especially with regard to parents with a lower educational level. By focusing on the association between SES and children's snack consumption, future research should also seek to explain socio-economic inequalities in children's snack consumption.

References

1. Kosti RI, Panagiotakos DB: **The epidemic of obesity in children and adolescents in the world.** *Cent Eur J Public Health* 2006, **14**:151–9.
2. Wang Y, Lobstein T: **Worldwide trends in childhood overweight and obesity**. *Int J Pediatr Obes* 2006, **1**:11–25.
3. Han JC, Lawlor DA, Kimm SYS: **Childhood obesity.** *Lancet* 2010, **375**:1737–48.
4. Owen CG, Whincup PH, Orfei L, Chou Q-A, Rudnicka AR, Wathern AK, Kaye SJ, Eriksson JG, Osmond C, Cook DG: **Is body mass index before middle age related to coronary heart disease risk in later life? Evidence from observational studies.** *Int J Obes (Lond)* 2009, **33**:866–77.
5. Rennie KL, Johnson L, Jebb SA: **Behavioural determinants of obesity.** *Best Pract Res Clin Endocrinol Metab* 2005, **19**:343–58.
6. Wang YC, Bleich SN, Gortmaker SL: **Increasing caloric contribution from sugar-sweetened beverages and 100% fruit juices among US children and adolescents, 1988-2004.** *Pediatrics* 2008, **121**:e1604–14.
7. Brug J, van Stralen MM, Chinapaw MJM, De Bourdeaudhuij I, Lien N, Bere E, Singh AS, Maes L, Moreno L, Jan N, Kovacs E, Lobstein T, Manios Y, Te Velde SJ: **Differences in weight status and energy-balance related behaviours according to ethnic background among adolescents in seven countries in Europe: the ENERGY-project.** *Pediatr Obes* 2012.
8. Van Lippevelde W, te Velde SJ, Verloigne M, De Bourdeaudhuij I, Manios Y, Bere E, Jan N, Fernández-Alvira JM, Chinapaw MJM, Bringolf-Isler B, Kovacs E, Brug J, Maes L: **Associations between home- and family-related factors and fruit juice and soft drink intake among 10- to 12-year old children. The ENERGY project.** *Appetite* 2013, **61**:59–65.
9. Piernas C, Popkin BM: **Trends in snacking among U.S. children.** *Health Aff (Millwood)* 2010, **29**:398–404.
10. Kelder SH, Perry CL, Klepp KI, Lytle LL: **Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors.** *Am J Public Health* 1994, **84**:1121–6.
11. Craigie AM, Lake A a., Kelly S a., Adamson AJ, Mathers JC: **Tracking of obesity-related behaviours from childhood to adulthood: A systematic review.** *Maturitas* 2011, **70**:266–84.
12. Swinburn B, Egger G, Raza F: **Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity.** *Prev Med (Baltim)* 1999, **29**(6 Pt 1):563–70.
13. Verloigne M, Van Lippevelde W, Maes L, Brug J, De Bourdeaudhuij I: **Family- and school-based correlates of energy balance-related behaviours in 10-12-year-old children: a systematic review within the ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project.** *Public Health Nutr* 2012, **15**:1380–95.
14. Lindsay AC, Sussner KM, Kim J, Gortmaker S: **The role of parents in preventing childhood obesity.** *Future Child* 2006, **16**:169–86.
15. Haerens L, Craeynest M, Deforche B, Maes L, Cardon G, Bourdeaudhuij I De, De Bourdeaudhuij I: **The contribution of psychosocial and home environmental factors in explaining eating behaviours in adolescents.** *Eur J Clin Nutr* 2008, **62**:51–9.

16. Verloigne M, Van Lippevelde W, Maes L, Brug J, De Bourdeaudhuij I: **Family- and school-based predictors of energy balance-related behaviours in children: a 6-year longitudinal study.** *Public Health Nutr* 2013, **16**:202–11.
17. Verzeletti C, Maes L, Santinello M, Vereecken C a: **Soft drink consumption in adolescence: associations with food-related lifestyles and family rules in Belgium Flanders and the Veneto Region of Italy.** *Eur J Public Health* 2010, **20**:312–7.
18. Hendrie G, Sohonpal G, Lange K, Golley R: **Change in the family food environment is associated with positive dietary change in children.** *Int J Behav Nutr Phys Act* 2013, **10**:4.
19. Pearson N, Ball K, Crawford D: **Predictors of changes in adolescents' consumption of fruits, vegetables and energy-dense snacks.** *Br J Nutr* 2011, **105**:795–803.
20. Golan M, Crow S: **Parents Are Key Players in the Prevention and Treatment of Weight-related Problems**. *Nutr Rev* 2004, **62**:39–50.
21. Wouters EJ, Larsen JK, Kremers SP, Dagnelie PC, Geenen R: **Peer influence on snacking behavior in adolescence.** *Appetite* 2010, **55**:11–7.
22. Van Ansem WJ, Schrijvers CT, Rodenburg G, Van de Mheen D: **Child snack consumption: role of parents, peers and child snack purchasing behaviour. Results from the Dutch INPACT study**. *Submitt Publ* .
23. Fletcher A, Bonell C, Sorhaindo A: **You are what your friends eat: systematic review of social network analyses of young people's eating behaviours and bodyweight.** *J Epidemiol Community Health* 2011, **65**:548–55.
24. Jensen JD, Bere E, Bourdeaudhuij I De, Jan N, Maes L, Manios Y, Martens MK, Molnar D, Moreno LA, Singh AS, Velde S, Brug J, De Bourdeaudhuij I, Te Velde S: **Micro-level economic factors and incentives in Children's energy balance related behaviours - findings from the ENERGY European cross-section questionnaire survey.** *Int J Behav Nutr Phys Act* 2012, **9**:136.
25. **NIBUD (National Institute For Familiy Finance Information** [http://www.nibud.nl/omgaan-met-geld/kinderen-en-geld/zakgeld.html]
26. Roberts BP, Blinkhorn AS, Duxbury JT: **The power of children over adults when obtaining sweet snacks.** *Int J Paediatr Dent* 2003, **13**:76–84.
27. Cutler GJ, Flood A, Hannan P, Neumark-Sztainer D: **Multiple sociodemographic and socioenvironmental characteristics are correlated with major patterns of dietary intake in adolescents.** *J Am Diet Assoc* 2011, **111**:230–40.
28. Craig LC a, McNeill G, Macdiarmid JI, Masson LF, Holmes B a: **Dietary patterns of school-age children in Scotland: association with socio-economic indicators, physical activity and obesity.** *Br J Nutr* 2010, **103**:319–34.
29. De Coen V, Vansteelandt S, Maes L, Huybrechts I, De Bourdeaudhuij I, Vereecken C: **Parental socioeconomic status and soft drink consumption of the child. The mediating proportion of parenting practices.** *Appetite* 2012, **59**:76–80.
30. Vereecken C, Keukelier E, Maes L: **Influence of mother's educational level on food parenting practices and food habits of young children.** *Appetite* 2004, **43**:93–103.
31. Danielzik S, Czerwinski-Mast M, Langnäse K, Dilba B, Müller MJ: **Parental overweight, socioeconomic status and high birth weight are the major determinants of overweight and obesity in 5-7 y-old children: baseline data of the Kiel Obesity Prevention Study (KOPS).** *Int J Obes Relat Metab Disord* 2004, **28**:1494–502.
32. Winkleby MA, Jatulis DE, Frank E, Fortmann SP: **Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease.** *Am J Public Health* 1992, **82**:816–820.
33. Bogers RP, Van Assema P, Kester ADM, Westerterp KR, Dagnelie PC: **Reproducibility, validity, and responsiveness to change of a short questionnaire for measuring fruit and vegetable intake.** *Am J Epidemiol* 2004, **159**:900–9.
34. Haraldsdóttir J, Thórsdóttir I, de Almeida MDV, Maes L, Pérez Rodrigo C, Elmadfa I, Frost Andersen L: **Validity and reproducibility of a precoded questionnaire to assess fruit and vegetable intake in European 11- to 12-year-old schoolchildren.** *Ann Nutr Metab* 2005, **49**:221–7.
35. Van der Horst K, Oenema A, van de Looij-Jansen P, Brug J: **The ENDORSE study: research into environmental determinants of obesity related behaviors in Rotterdam schoolchildren.** *BMC Public Health* 2008, **8**:142.
36. Gattshall ML, Shoup JA, Marshall JA, Crane LA, Estabrooks PA: **Validation of a survey instrument to assess home environments for physical activity and healthy eating in overweight children.** *Int J Behav Nutr Phys Act* 2008, **5**:3.
37. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH: **Establishing a standard definition for child overweight and obesity worldwide: international survey.** *BMJ* 2000, **320**:1240–3.
38. Baron RM, Kenny DA: **The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations.** *J Pers Soc Psychol* 1986, **51**:1173–82.
39. Chapelot D: **The role of snacking in energy balance: a biobehavioral approach.** *J Nutr* 2011, **141**:158–62.
40. Hupkens CL, Knibbe RA, Van Otterloo AH, Drop MJ: **Class differences in the food rules mothers impose on their children: a cross-national study.** *Soc Sci Med* 1998, **47**:1331–1339.
41. Bruening M, Eisenberg M, MacLehose R, Nanney MS, Story M, Neumark-Sztainer D: **Relationship between adolescents' and their friends' eating behaviors: breakfast, fruit, vegetable, whole-grain, and dairy intake.** *J Acad Nutr Diet* 2012, **112**:1608–13.
42. Fitzgerald A, Heary C, Kelly C, Nixon E, Shevlin M: **Self-efficacy for healthy eating and peer support for unhealthy eating are associated with adolescents' food intake patterns.** *Appetite* 2013, **63**:48–58.
43. Heim S, Bauer KW, Stang J, Ireland M: **Can a community-based intervention improve the home food environment? parental perspectives of the influence of the delicious and nutritious garden.** *J Nutr Educ Behav* , **43**:130–4.
44. Baranowski T, Davis M, Resnicow K, Baranowski J, Doyle C, Lin LS, Smith M, Wang DT: **Gimme 5 fruit, juice, and vegetables for fun and health: outcome evaluation.** *Health Educ Behav* 2000, **27**:96–111.

chapter 7

Characteristics of the local food environment: Can they explain socio-economic disparities in children's fruit and vegetable consumption?

Results from the INPACT study

chapter 8

General discussion

General discussion

8.1 Introduction

This thesis focuses on environmental determinants of children's dietary behaviour. Dietary behaviour is related to a wide range of health outcomes, including obesity and several chronic diseases. Unfortunately, many children do not show favourable dietary behaviour. Moreover, a poor dietary intake is more common among children from parents with a low educational background. To prevent childhood obesity and chronic diseases later in life, there is a need for effective promotion of healthy dietary behaviour of children. Therefore, more insight in the underlying determinants of dietary behaviour of children is necessary. It is also important to identify modifiable determinants that may explain the socio-economic inequalities in children's dietary behaviour.

Because the rising prevalence of obesity rates cannot be fully explained by individual factors, an increasing number of studies are investigating the influence of environmental factors on children's dietary behaviour. Socio-ecological models describe the involvement of different types and levels of the environment and behaviour. Moreover, individuals interact with the environment in multiple micro-settings. For children, it is most likely that the environment will be determined within the home, school and neighbourhood. Therefore, this thesis focuses on determinants of these environmental settings and the interaction between these determinants.

The aims of this thesis are:

- To investigate modifiable environmental determinants of dietary behaviour of primary school children aged 10-12 years.
- To investigate socio-economic inequalities in dietary behaviour of primary school children aged 10-12 years.
- To investigate whether modifiable environmental factors can explain socio-economic inequalities among primary school children aged 10-12 years.

This final chapter summarises the main findings of the studies presented here. Furthermore, some methodological issues are discussed and the findings are related to the currently available literature. Finally, implications for research and practice emerging from this work are discussed and this chapter ends with our conclusion.

8.2 Main findings

Studies in the first part of this study explored determinants of the home, school and neighbourhood environment on children's dietary behaviour. **Chapter 2** reports on the association between parental perceptions of the local food shopping environment (price, availability and variety of fruit and vegetables in shops), the home availability of fruit and vegetables, and children's consumption of fruit and vegetables. Home availability of fruit and vegetables was positively associated with children's fruit and vegetable intake. Furthermore, negative parental perceptions of the local food shopping environment were associated with a reduced availability of fruit at home. Unexpectedly, no associations were found between parental perceptions of the local food shopping environment and children's fruit and vegetable intake. An explanation for this finding may be that parental perceptions of the local food shopping environment are too distal to directly influence child behaviour. Finally, no evidence was found that the home availability of fruit and vegetables mediated the association between parental perceptions of the local food shopping environment and children's fruit and vegetable consumption.

Chapter 3 explores the school food policy at Dutch primary schools. More specifically, it describes the presence, content and implementation of the school food policy. Furthermore, we investigated the schools' (i.e. teachers and principals) and parents' opinion on the school food policy (e.g. appreciation of the school food policy, and the role of schools in fostering healthy eating habits among children). Most primary schools had a written food policy and informed parents about the food rules. Furthermore, in most schools education on nutrition was part of the school curriculum and most schools participated in specific nutrition projects. Most parents reported that they appreciated the school food policy and complied with the food rules. Most principals felt that they had only a supportive role to foster healthy eating behaviour among children and considered parents to be primarily responsible. About half of the parents felt that schools should play a role in encouraging healthy food habits among children. The school food policy could be improved by clearly formulating food rules, simplifying supervision of the food rules, and defining how to enforce the food rules.

Chapter 4 reports on the associations between parental factors (home availability of snacks and snack consumption rules) and peer sensitivity on children's snack consumption. It also explores whether child's snack purchasing behaviour is a mediator between these associations. Home availability of snacks was associated with children's snack consumption: children consumed more snacks when snacks were always available at home. Home availability of snacks was not associated with children's snack purchasing behaviour. Peer sensitivity was positively associated with children's snack consumption and children's snack purchasing behaviour. A small part of the association between peer sensitivity and children's snack consumption was explained by children's snack purchasing behaviour.

The second part of this thesis focuses on socio-economic inequalities in the dietary behaviour of primary school children and investigates whether modifiable environmental factors can explain such inequalities in children's dietary behaviour. **Chapter 5** investigates socio-economic inequalities in healthy eating behaviours of children (fruit, vegetable and breakfast consumption). Maternal educational level was used as an indicator for socio-economic status (SES). Furthermore, this study examines whether factors in the home food environment (parental intake of fruit, vegetables and breakfast; rules about fruit and vegetables, and home availability of fruit and vegetables) mediate the association between maternal educational level and children's healthy eating behaviours (fruit, vegetable and breakfast consumption). Children from parents with a high SES consumed more fruit and vegetables per week and were also more likely to consume breakfast on a daily basis. All the studied home environmental factors mediated the association between children's SES and their healthy dietary behaviour. Moreover, the results indicate that socio-economic inequalities in fruit and vegetables consumption were explained in particular by parental intake of fruit and vegetables.

Chapter 6 explores the extent to which various types of micro-environmental factors explain socio-economic inequalities in children's consumption of sugar-sweetened beverages (SSBs) and energy-dense snacks. The environmental factors include home availability of SSBs and snacks, rules about snacks and SSBs and parental intake of SSBs and snacks, peer sensitivity, and children's snack purchasing behaviour. Maternal educational level was used as an indicator of the SES of the children. Children with a high SES had the lowest snack and SSB consumption compared to children with an intermediate and low SES. None of the studied micro-environmental factors mediated the association between children's SES and their snack consumption. Home availability of SSBs and parental intake of SSBs mediated the association between children's SES and their SSB consumption.

Chapter 7 investigates whether characteristics of the local food environment can contribute to socio-economic inequalities in children's fruit and vegetable consumption. Food store audits were conducted and matched with survey data of 292 children living in the city of Eindhoven. Child's SES was based on maternal educational level. For each child we determined the local food area around his/her house, defined as an 800-metre radius around the house. In the local food area we assessed: 1) the density of food stores, 2) the density of food stores per store type, 3) the mean variety of fruit and vegetables available in the food stores, and 4) the mean price of fruit and vegetables in the available food stores. Children with a low SES had a significantly lower fruit consumption compared to high SES children. No significant association was found between children's socio-economic background and their consumption of vegetables. We found no differences in the studied characteristics of the local food environment between children from various socio-economic backgrounds.

8.3 Methodological considerations

The studies described in this thesis are subject to some methodological issues concerning study design, data assessment, analytical approach, and the effect size of the associations. These methodological issues need to be kept in mind when interpreting the results of the individual studies, and are described below.

8.3.1 Study design

In this thesis various research designs were used to investigate the research questions. All data used were derived from the Dutch INPACT study, which is an observational study. Because investigators have no control over the assignment of different exposures in an observational study, it is not possible to draw firm causal conclusions about what causes the behaviour under study.

Another important issue of consideration in cohort studies is selective dropout of the participants. In 2011 (the third wave of the INPACT study), 1428 of the 1840 parents that started in 2008 (first wave of the INPACT study) were still participating in the INPACT study. The attrition rate of 22.4% is relatively low compared to that of similar cohort studies [1]. Analyses on selective dropout showed that parents of immigrant children dropped out more often. There was no selective dropout on child age and gender, and maternal educational level. Presumably, immigrant parents who were not fluent in the Dutch language dropped out more often.

Cross-sectional approach

The statistical analyses in all the studies presented here used a cross-sectional dataset. As cross-sectional study designs are carried out at one point in time, it is not possible to elucidate the direction of the associations investigated. For example, we expected parental rules to predict the amount of food children consume, but it is also possible that children's dietary behaviour contributes to parents setting rules about the food that children are allowed to consume. Also, in the case of other home environmental factors (parental dietary behaviour and home availability) and peer influence, it is possible that the directions of the associations are to some extent in the opposite direction to that which we hypothesized in our research model. The general response to this drawback of cross-sectional analyses, is to carry out longitudinal analyses. Although a longitudinal design allows to draw stronger conclusions about possible causal interferences than a cross-sectional design, a longitudinal design is not a guarantee that valid causal relationships can be drawn [2]. In this thesis, longitudinal analyses, in which determinants were related to changes in children's dietary behaviour over time, would probably not lead to a causal interpretation as the follow-up period of one year may be too short to measure meaningful changes in children's dietary behaviour. Also, because it is unlikely that children's dietary behaviour or the home environment will affect maternal educational level, in this thesis we presumed maternal educational level to be a predictor of dietary behaviour. Therefore, it was not necessary to study the relationship between maternal educational level and children's dietary behaviour or home environmental factors in a longitudinal design.

Study population
In the INPACT study the parent-child dyads were recruited through primary schools in the southern part of the Netherlands. All primary schools (n=265) in this area were invited to participate in the INPACT study, and 91 schools agreed (31.1%). As the response of both urban and rural schools was similar, we do not expect selection bias of schools to be a major concern.
At baseline (2008), 1840 parent-child dyads were included (62.4% of all invited parent-child dyads). Unfortunately, because no data were obtained from the parent-child dyads who refused to participate in the study, we have no information about possible selection bias of the parent-child dyads.

In the INPACT study a one-parent approach was used (i.e. the primary caregiver was asked to fill in the questionnaire). This may limit the validity of the measurements on paternal influences on children's dietary behaviour, especially when the parents are not cohabiting. The choice for a one-parent approach was based on practical considerations. In a large-scale observational study it is difficult to follow both parents over time, especially when the parents are divorced. Therefore, it was expected that following both parents would result in a high non-response of the parents.

Study setting
The INPACT study took place in the southern part of the Netherlands (Eindhoven and surroundings). Therefore, the results may not be simply generalisable to other parts of the Netherlands. However, in relation to the aims of this thesis (i.e. to improve insight in the determinants of dietary behaviour), the determinants of children's dietary behaviour is not expected to be substantially different in other parts of the Netherlands.

Not all the results presented here can be generalised to other countries. For example, the results of the school food policy at Dutch schools (Chapter 3) cannot be generalised to other countries, as the school system in the Netherlands differs from that in most other countries (e.g. Dutch primary schools do not offer meals at school, and have no vending machines or a canteen). Also the results of Chapter 7 may not be generalised to other countries; that study (characteristics of the local food environment) was based on data of the child-parent dyads who lived in the city of Eindhoven. Compared with other countries, the Netherlands will differ in terms of population characteristics, urban sprawl and cultural factors. For example, residential segregation may be higher in the US than in the Netherlands, and this may also create differences in the food environment between countries.

8.3.2 Data assessment
In this thesis, data were assessed through questionnaires (both parent and child reports), neighbourhood observations and interviews**.** Implications related to the use of these methods are discussed below.

Parental and child questionnaires
Self-reported data were used to measure dietary behaviour, home environmental factors, parental perceptions about the school food environment, and parental perceptions about the local food shopping environment. Although self-reported data are common in large-scale observational studies due to practical considerations, they do have some drawbacks. First, self-reported data may be susceptible to recall bias and social-desirability bias. For example, it is likely that parents overreported the consumption of fruit, vegetable and breakfast consumption (both for themselves and for their children), while the consumption of SSBs is likely to be underreported. Also, it cannot be excluded that parents reported to always have fruit and vegetables available at home and to have rules regarding children's dietary behaviour, even when this was not the case. Furthermore, parental reports on children's fruit, vegetable and SSB consumption could also lead to bias, as parents may not be fully aware of their child's dietary behaviour outside the home environment. These potential biases may lead to overreporting or underreporting of dietary behaviour and related environmental correlates. We attempted to minimise such forms of bias as much as possible by using validated questionnaires where available. Children's dietary behaviour was assessed using several items from validated food frequency questionnaires designed to assess the energy intake of 2-21 year old children in the Netherlands [3–5]. Furthermore, to assess home food environmental factors, items were used from the validated Home Environment survey [6]. Unfortunately, in some cases no validated questionnaires were available. In this situation, we tried to use questionnaires from ongoing studies in the Netherlands or other countries. For example, to measure parental perceptions of the local food shopping environment we derived the questions from the GLOBE study [7]. The questions used to assess parental rules regarding specific dietary behaviour were derived from the ENDORSE study [8].
In the case of peer sensitivity, children's purchasing behaviour and parental perceptions of the school food environment, we developed the questions ourselves as no relevant questionnaires from other studies were available. Therefore, the development of valid and reliable questionnaires to measure peer sensitivity, children's purchasing behaviour and parental perceptions of the school food environment needs attention in future research.

Neighbourhood observations
Objective data on the consumer nutrition environment and the community nutrition environment were assessed through neighbourhood observations. Although this multi-dimensional approach gives a more comprehensive overview of the local food environment [9, 10], some drawbacks of the neighbourhood observation study (Chapter 7) should be taken into account when interpreting the results. First, a major difficulty in measuring characteristics of the local food shopping environment is the determination of an appropriate buffer size in which shopping behaviour takes place. The buffer size is probably dependent on the study population (e.g. children, adolescents or adults) and the behaviour under study (e.g. physical activity or grocery shopping). For children, the buffer size of their local environment, in which they play or purchase foods, may be smaller than for adults. Therefore, researchers should carefully consider which buffer size is most appropriate for the purpose of their study. In our study, we chose a buffer size of 800 metres, which is commonly used to determine the area of a 10-15 minute walk [11, 12]. Although this is a commonly used buffer size, the chosen buffer size may not cover the area where the participants' shops are located and this may have influenced our results. However, because we found no significant differences in the density of food stores or in the price and availability of fruit and vegetables, we believe our results would not have been different had we used a different buffer size.

Second, the in-shop audits only assessed the price and availability of the five most commonly consumed fruit and vegetables in the Netherlands. Furthermore, only fresh fruit and vegetables were assessed, while there is a large range of frozen and canned fruits/vegetables. Moreover, people may also buy fruit and vegetable at the local market, which was not included as a selling point for fruit and vegetables in this study. However, as there was no significant price differences in fruit and vegetables between the different types of stores, these issues probably had no substantial effect on our results.
Although neighbourhood observations can provide valuable information about the consumer nutrition environment and community nutrition environment in a specific buffer, it remains unclear where people actually shop and which underlying mechanisms determine which kind of food products they purchase. To accurately measure the influence of characteristics of the local food shopping environment, future studies should collect all of this type of information.

8.3.3 Analytical approach: mediation analyses

In several of the studies presented in this thesis, mediation analyses were performed. Mediation analyses provide insight into the associations between variables in a potential causal chain; in fact they can determine the influence of each link in the causal chain [13].
To perform the mediation analyses the 4-step approach of Baron and Kenny was used. According to Baron and Kenny a mediator must meet the following criteria: 1) the predictive variable has to be significantly associated with the outcome variable, 2) the predictive variable has to be significantly associated with the mediator,3) the mediator has to be significantly associated with the outcome variable (adjusted for the predictive variable), and 4) after adjustment for the potential mediator, a previously significant association between the predictive variable and the outcome variable is no longer significant or is significantly attenuated [14]. In order to assess the reduction in association between the independent and dependent variable after inclusion of the mediators, we calculated confidence intervals using bootstrapping resampling techniques. Although the approach of Baron and Kenny is widely used, it has some disadvantages concerning interaction, non-linearity and causal interpretation. For example, in order to have causal interpretation it requires no unmeasured confounders. Although, we controlled for confounders in the mediation analyses we cannot be sure that there are no unmeasured confounders. Consequently, this may have biased the results of our mediated effects. Recently, mediation methods based on a counterfactual approach have been developed which may be more suitable when the causal relationships under study are more complex or when investigators are faced with non-linearity and interactions [15].

8.3.4 Effect sizes

A final consideration when interpreting the finding of this thesis is the effect sizes. Although many variables were found to be statistically significant, the effect sizes were often small. Several factors may explain the small effect sizes. First, this thesis investigates environmental factors of children's dietary behaviour and each study focuses on a small part of the complex interplay between environmental factors and behaviour. Moreover, environmental factors are relatively distal in the causal chain explaining children's dietary behaviour and may have resulted in small effect sizes. However, children's dietary behaviour is influenced by additional environmental determinants. For example, children's fruit consumption is associated with home availability of fruit, parental consumption of fruit, and parental rules regarding children's fruit intake. Although these environmental factors may have limited effect sizes separately, the combined effect is probably much larger.

Small effect sizes are not uncommon in research examining the environmental determinants of dietary behaviour [16, 17]. As environmental factors can be changed, and have the potential to reach and influence the behaviour of many people, environmental factors are important targets for health interventions. Furthermore, some of these environmental factors are also associated with other health behaviour. For example, parental rules and parental behaviour were associated with children's fruit, vegetable and SSB intake [18–23], but also related to the physical activity of children [24–26]. Therefore, by targeting environmental determinants other health outcomes can also be influenced.

8.4 Integration and reflection on the main findings

This thesis provides insight in the influence of environmental determinants of children's dietary behaviour, and in understanding socio-economic inequalities in children's dietary behaviour. This section discusses and interprets the study's main findings.

8.4.1 Environmental determinants of children's dietary behaviour

The first aim of this thesis was to investigate modifiable environmental determinants of dietary behaviour of primary school children. As the home environment, school environment and neighbourhood are the environmental settings which schoolchildren encounter, we studied modifiable characteristic of these environmental settings. Below, we discuss the findings for each of the environmental settings separately.

Home environment

We found a significant association between home availability of food and children's fruit, vegetable, snack and SSB consumption. Also, a significant association was found between parental intake of fruit, vegetables and SSB and children's consumption of fruit, vegetables and SSB. In the case of parental rule setting, a significant association was found with children's fruit and vegetable consumption. These findings are in line with previous (review) studies [20, 27, 28] and indicate that home-environmental factors are important in explaining children's dietary behaviour. As parents shape the home environment, set rules and act as role models, they play an important role in the development of children's dietary behaviour. Therefore, parents are an important target group for interventions aimed at improving children's dietary behaviour. However, contrary to our expectations, we did not find a significant association between parental rule setting and children's snack and SSB consumption. Also, contrary to our expectations, no association was found between parental snack consumption and children's snack consumption. A possible explanation might be that children not only consume snacks and/or SSB at home, but also at school or with friends and, thereby, do not conform with parental rules when they are not at home.

School environment

We investigated schools' and parents' perspective of the school food environment at Dutch primary schools to find opportunities to improve the school food policy. Although most primary schools had a written food policy and parents generally appreciated the school food rules, the school food policy can be improved. These improvements include clearly formulated food rules, simplifying the supervision of the food rules, and defining how to enforce the food rules. In addition, both parents and school staff should fully support the school food policy. Previous studies have shown that the school food policy can improve children's dietary behaviour [29–31]. Therefore, the school food policy seems a very promising tool to improve children's dietary behaviour, and our study yields valuable recommendations to improve the school food policy at Dutch primary schools.

In addition, we investigated the influence of peers on children's snack consumption. It was found that children who were sensitive to peer influence consumed more snacks. We also found that children's snack purchasing behaviour mediated the association between peer sensitivity and children's snack consumption. Previous studies found that the presence of 'others' influences children's and adolescents' eating behaviour, regardless of feelings of hunger and satiety [32]. Furthermore, it was found that peers have an influence on children's food purchasing behaviour and children's food choice [33, 34]. Although our findings, and the current literature on peer influence and children's dietary behaviour, indicate that peers may be a promising target for interventions aiming to improve children's dietary behaviour, little is known about how to target peer influence. A promising way to target peer influence may be a school-based peer-led intervention. In such an intervention, influential students (identified by classmates) will be trained as 'peer supporters' to intervene in everyday situations and encourage peers to choose a healthy lifestyle [35]. This approach has shown positive effects in a 'stop smoking' intervention among adolescents [36]. It was also found that such an approach may also be feasible for an obesity prevention intervention, although it was labour intensive and relatively expensive [35]. However, in order to modify peer influence, future studies should further elucidate the mechanisms of how, why and in which contexts, peers influence children's dietary behaviour.

Neighbourhood environment

We found no significant association between parental perceptions of the local food shopping environment and children's fruit and vegetable intake. A possible explanation for this lack of association may be that parental perceptions are too distal to directly influence children's eating behaviours. However, several studies examining the association between perceptions of the local food environment and adults' dietary behaviour found that how people perceive their neighbourhood food environment is associated with their dietary behaviour and their food purchasing behaviour [37–39]. This suggests that parental perceptions of the food shopping environment may influence parents' own food consumption and their food purchasing behaviour. This was partly supported by our finding that parental perceptions of the price, availability and quality of fruit was associated with the home availability of fruit (Chapter 2). That same study found that the home availability of fruit was associated with children's fruit intake. This suggests that parental perceptions of the local food environment may indirectly influence children's dietary behaviour. Nevertheless, because the influence of parental perceptions of the food environment on children's dietary behaviour seem very small, interventions to improve children's dietary behaviour should target additional environmental factors.

8.4.2 Socio-economic inequalities and children's dietary behaviour

It was found that children with a high SES consumed significantly more fruit and vegetables (Chapter 5) and were more likely to eat breakfast on a daily basis (Chapter 6), than their counterparts with a low SES. Also, we found that children with a high SES had the lowest consumption of snacks and SSBs, while children with an intermediate SES had the highest snack consumption, and children with a low SES had the highest SSB consumption (Chapter 6).

No socio-economic inequality in children's vegetable consumption was found (Chapter 7). This is probably because this study included only a small subsample of 292 INPACT participants (only children who lived in Eindhoven). Analyses of the total INPACT study revealed significant socio-economic inequalities in children's vegetable consumption (Chapter 5 and Chapter 7).

Unexpectedly, no significant difference in snack consumption between children with a high and low SES was found. This may be due to the difficulty of accurately measuring snack consumption. Although we distinguished three categories of energy-dense snacks (savoury snacks, sweet snacks, and cake or large biscuits) we did not know the actual energy intake from snacks, and children from a low socio-economic background may have consumed more energy-dense snacks than children from a higher socio-economic background.

However, overall, our results are in line with others that also found that children with a high SES had more favourable dietary habits [40–47]. Our findings indicate that children from lower SES groups are important targets for interventions to reduce socio-economic inequalities in children's dietary behaviour.

To improve the dietary behaviour of children from lower socio-economic groups, understanding of the mechanisms underlying the socio-economic inequalities in children's dietary behaviour is necessary. In several studies we examined whether environmental factors differed between children from various socio-economic backgrounds. Moreover, we studied whether these environmental factors could explain the socio-economic inequalities in children's dietary behaviour. We found that children with a low SES had the least favourable home food environment (e.g. they were less likely to always have fruit and vegetables available at home, and more likely to always have SSB available at home). Home availability, parental rules and parental intake of fruit and vegetables mediated the association between SES and children's fruit and vegetable intake. In the case of SSBs, we found that home availability and parental intake of SSBs mediated the association between children's SES and their SSB consumption. These findings are in line with other studies reporting that home environmental factors mediated the association between children's SES and their dietary behaviour [42, 48, 49]. We conclude that home environmental factors partly explain the socio-economic inequalities in children's dietary behaviour. Thus, home environmental factors may be a good target point for interventions to reduce socio-economic inequalities in children's dietary behaviour.

A recent study investigated the differential effectiveness of Dutch interventions aimed at the prevention of obesity, and the promotion of physical activity or healthy diet by SES. For the majority of the included interventions, no evidence was found for differential effectiveness. It appeared that most interventions focused on adults. Evidence for studies particularly effective in adolescent youth were scarce, and no such studies were found for children. This stresses the need for effective interventions aiming to reduce socio-economic inequalities in children's dietary behaviour [50].

Contrary to our expectations and to previous research [51], we found no association between children's SES and the home-environmental determinants of snacking (i.e. home availability of snacks, snack consumption rules, and parental intake of snacks). A possible explanation for this lack of association between children's SES and the home-environmental determinants of snacking, may be the questionnaire used to measure the home-environmental determinants of snacking. This questionnaire did not distinguish between different categories of snacks and may not be precise enough to detect inequalities in children's snack intake. Therefore, it remains unclear whether there are socio-economic inequalities in the availability of high-caloric snacks. Using more extensive questionnaires, future studies should examine whether (home) environmental factors can explain socio-economic inequalities in children's snack consumption.

We found no inequalities in the characteristics of the community nutrition environment (store type and density) and consumer nutrition environment (price and variety of fruit and vegetables in stores) between children from various socio-economic backgrounds. In contrast, in the USA there is corresponding evidence that residents of low income neighbourhoods have disproportionally poorer access to healthy food and greater access to stores selling less healthy food [52–54]. The evidence for inequalities in access to healthy food in other countries such as the UK, Australia and Canada, is equivocal [52].
These equivocal results may reflect actual differences in landscape regarding the spatial location of food stores and neighbourhood characteristics. Especially in the USA there is a strong degree of racial and economic residential segregation, which probably influences the spatial location of food stores resulting in variation in the types and density of food stores by neighbourhood SES and ethnicity. In contrast, in the Netherlands there is less variation in neighbourhood residents.
The consumer nutrition environment is less extensively studied and mixed results are reported between countries [52, 55]. For example, a study in Brisbane (Australia) found no differences in fruit and vegetables price and availability by neighbourhood deprivation [56], while studies in the UK [57, 58] and Canada [59] reported cheaper food prices in more deprived areas. The conflicting results between different countries indicate that the association between area deprivation and the consumer nutrition environment is context dependent. Our results indicate that interventions in the Netherlands to reduce socio-economic inequalities in children's fruit and vegetable consumption should not focus on characteristics of the local food environment, but on characteristics of other environmental settings, such as the home food environment.

8.4.3 Reflections on the food environment

The results of the studies presented in this thesis show that environment determinants influence children's dietary behaviour. The Western environment has changed over the last decades and has shifted from a society based on agriculture to a consumer society [60]. It is thought that these changes in environments are important drivers of the increase in prevalence of obesity and, therefore, the Western food environment is sometimes called the *obesogenic* environment. The *obesogenic* environment is thought to facilitate overconsumption of high-caloric foods and to discourage physical activity [61]. The changes in the food environment are characterised by an increasing availability of (ready to eat) food and larger portion sizes, which may affect people's food intake. Besides these changes, there are contextual food cues, like advertisements, which also influence people's food intake [62]. Although it is clear and recognised that environmental factors play a role in dietary behaviour, it remains unclear to which extent environmental changes are the drivers of the obesity epidemic. Moreover, the magnitude of environmental influences on dietary behaviour is context dependent.

8.5 Implications of the study findings

8.5.1 Implication for research

From an isolated to an integrative and holistic approach

It is recognised that health behaviour is influenced by environmental and individual determinants. Despite the increase in studies investigating the environmental determinants of dietary behaviour, most of them only examine separate factors of an environmental setting. According to the various socio-ecological theories, the environment consists of several levels and settings [63–66]. Moreover, the Ecological Systems Theory states an interaction between the different environmental systems and settings [64–65]. This means that individual behaviour takes places in different environmental settings, but also that factors from these different environmental setting interact with each other and influence human behaviour.
In this thesis, several environmental settings (home, school and neighbourhood) were studied. Although most of the environmental factors were studied separately, we made a very small step to study these factors in a more interactionist approach. For example, in Chapter 3 we studied the effect of factors of the neighbourhood and the home environment on children's dietary behaviour. Also examined was the effect of the neighbourhood environment on the food environment. It was found that neighbourhood factors (subjectively measured) influenced the home food environment. Our study on school food policy also indicates an interaction between the school food environment and parents. Future studies should examine the interaction between multiple environmental settings and dietary behaviour. Moreover, the focus should be more holistic and integrative in order to understand the collective and individual roles and responsibilities. Therefore, system thinking would be a promising approach which may increase insight into the complex interplay of contextual factors and dietary behaviour. Also, it may increase insight into how dietary behaviour can be improved.

Research should focus on children in the transition from childhood to adolescence
It is presumed that throughout the human lifespan different environmental settings are encountered that may influence (dietary) behaviour in different degrees. Several studies found that children's age interacts with environmental factors regarding their dietary behaviour [67, 68]. Therefore, researchers should carefully consider which environmental settings are encountered by their research population.
This thesis focused on the dietary behaviour of primary school children aged 10-12 years. Based on the age and life stage of these children, we focused our research on environmental determinants of the home, school and neighbourhood setting. Future research should focus on children shifting from primary school to secondary school, as the environmental settings of these children will also change. For example, with the change in school environment, peers will become more important while the influence of the home environment is likely to decrease. Therefore, it is assumed that this a critical period for changes in health behaviour.

Continue research on identifying modifiable determinants of socio-economic inequalities in children's dietary behaviour
The results presented here indicate that children from a lower socio-economic background show the least favourable dietary behaviour. In this thesis, we also investigated environmental factors that could explain these socio-economic inequalities. Although our results indicate several environmental factors that might explain the inequalities in dietary behaviour, more research is necessary. For example, we found that children from a lower socio-economic background were less likely to always have fruit and vegetables available at home, and were more likely to always have SSBs available at home. However, little is known about effective ways to improve the home food environment of children from lower socio-economic backgrounds.

8.5.2 Implication for policy and practice

Setting for intervention: home environment
This thesis indicates that home food availability, food rules and parental food intake are important home food environmental factors that need attention in interventions. Since parents shape the home food environment, parents play a crucial role in health interventions and are important targets. Parents should be made aware of their important role in shaping the home food environment. Moreover, parents should also be aware that their own dietary behaviour influences the dietary behaviour of their children. To improve the home food environment it is important that interventions engage families. As the home food environment is also influenced by local contextual factors, community-based interventions in which families are engaged seems a promising way to improve the home food environment.

Improving the school food policy at primary schools
Schools are considered to be an important setting for interventions to improve children's dietary behaviour, as children spend a significant part of their time at school and consume food and beverages during school time. Furthermore, schools can create a healthy food environment and stimulate healthy dietary behaviour among children. Because school food policy can improve children's dietary behaviour [29–31] it is recommended that all primary schools have such a school policy. Although our results show that most schools had a written policy, it appeared that the food rules were not always clearly formulated. Primary schools are advised to formulate clear rules about which food and beverages may be consumed during school time. Special attention should be paid to birthday celebrations. As teachers and principals may have insufficient nutritional knowledge, schools are advised to cooperate with a dietician when drafting the food policy. Also, a useful tool for drafting a school food policy may be the template of a school food policy of The Netherlands Nutrition Centre Foundation. Although having a clearly formulated food policy is the first step, this does not ensure monitoring and compliance with the policy. Schools should clearly define how the school food policy will be enforced and the policy should be enforced by the entire school staff.
The effectiveness of the policy is influenced by the content, implementation, communication and support of all stakeholders. Therefore, not only the schools are responsible for the school food policy. A school food policy will only be effective if the policy is supported by the entire school staff and the parents. Parents should be aware of the importance of a school food policy and should fully support the policy.

Reducing socio-economic inequalities in children's dietary behaviour
This thesis indicates that children from lower socio-economic backgrounds are an important target group for health interventions. As socio-economic health inequalities among children are considered to be unfair (as their SES is based on their parents SES), reducing socio-economic inequalities in children's dietary behaviour should be a priority in public health [69]. Our results show that inequalities in children's dietary behaviour are partly explained by home environmental determinants. However, it remains difficult to reach families with a low socio-economic background.
Researchers should apply more intensive recruitment strategies to involve families from lower SES groups [50]. Moreover, community-based intervention are often more likely to reach low SES groups. Whatever the case, low SES families should be involved in the development and implementation of an intervention in order to ensure that the intervention fits their demands [50, 70].

8.6 Final Remarks

Environmental factors play an important role in people's dietary behaviour. The magnitude and importance of environmental factors on dietary behaviour are generally context dependent. The results of this thesis indicate that, for primary school children aged 10-12 years, factors in the home food environment and school food environment are the most important.

References

1. Gubbels J: *Influence of Micro-Environments on Pre-School Children's Energy Balance-Related Behaviours and Weight Status*. Maastricht; 2010.
2. Taris TW, Kompier M: **Challenges in longitudinal designs in occupational health psychology**. *Scand J Work Environ Health* 2003, **29**:1–4.
3. Bogers RP, Van Assema P, Kester ADM, Westerterp KR, Dagnelie PC: **Reproducibility, validity, and responsiveness to change of a short questionnaire for measuring fruit and vegetable intake.** *Am J Epidemiol* 2004, **159**:900–9.
4. Dutman AE, Stafleu A, Kruizinga A, Brants HAM, Westerterp KR, Kistemaker C, Meuling WJA, Goldbohm RA: **Validation of an FFQ and options for data processing using the doubly labelled water method in children.** *Public Health Nutr* 2011, **14**:410–7.
5. Brants H, Stafleu A, Ter Doest D, Hulshof K: **Ontwikkeling van een voedselfrequentievragenlijst: energie-inneming van kinderen van 2 tot en met 12 jaar.** *Voeding Nu* 2006, **2**:25–28.
6. Gattshall ML, Shoup JA, Marshall JA, Crane LA, Estabrooks PA: **Validation of a survey instrument to assess home environments for physical activity and healthy eating in overweight children.** *Int J Behav Nutr Phys Act* 2008, **5**:3.
7. Giskes K, van Lenthe FJ, Kamphuis CBM, Huisman M, Brug J, Mackenbach JP: **Household and food shopping environments: do they play a role in socioeconomic inequalities in fruit and vegetable consumption? A multilevel study among Dutch adults.** *J Epidemiol Community Health* 2009, **63**:113–20.
8. Van der Horst K, Oenema A, van de Looij-Jansen P, Brug J: **The ENDORSE study: research into environmental determinants of obesity related behaviors in Rotterdam schoolchildren.** *BMC Public Health* 2008, **8**:142.
9. Rose D, Bodor JN, Hutchinson PL, Swalm CM: **The importance of a multi-dimensional approach for studying the links between food access and consumption.** *J Nutr* 2010, **140**:1170–4.
10. Caspi CE, Sorensen G, Subramanian S V, Kawachi I: **The local food environment and diet: a systematic review.** *Health Place* 2012, **18**:1172–87.
11. Skidmore P, Welch A, van Sluijs E, Jones A, Harvey I, Harrison F, Griffin S, Cassidy A: **Impact of neighbourhood food environment on food consumption in children aged 9-10 years in the UK SPEEDY (Sport, Physical Activity and Eating behaviour: Environmental Determinants in Young people) study.** *Public Health Nutr* 2010, **13**:1022–30.
12. Timperio A, Ball K, Roberts R, Campbell K, Andrianopoulos N, Crawford D: **Children's fruit and vegetable intake: associations with the neighbourhood food environment.** *Prev Med (Baltim)* 2008, **46**:331–5.
13. Lockwood CM, DeFrancesco CA, Elliot DL, Beresford SAA, Toobert DJ: **Mediation analyses: applications in nutrition research and reading the literature.** *J Am Diet Assoc* 2010, **110**:753–62.
14. Baron RM, Kenny DA: **The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations.** *J Pers Soc Psychol* 1986, **51**:1173–82.
15. Valeri L, Vanderweele TJ: **Mediation analysis allowing for exposure-mediator interactions and causal interpretation: theoretical assumptions and implementation with SAS and SPSS macros.** *Psychol Methods* 2013, **18**:137–50.
16. Van der Horst K, Oenema a, Ferreira I, Wendel-Vos W, Giskes K, van Lenthe F, Brug J: **A systematic review of environmental correlates of obesity-related dietary behaviors in youth.** *Health Educ Res* 2007, **22**:203–26.
17. Ferreira I, Horst K Van der: **Environmental correlates of physical activity in youth–a review and update**. *Obes …* 2007.
18. Krølner R, Rasmussen M, Brug J, Klepp K-I, Wind M, Due P: **Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part II: qualitative studies.** *Int J Behav Nutr Phys Act* 2011, **8**:112.
19. Rasmussen M, Krølner R, Klepp K-I, Lytle L, Brug J, Bere E, Due P: **Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies.** *Int J Behav Nutr Phys Act* 2006, **3**:22.
20. Pearson N, Biddle SJH, Gorely T: **Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review.** *Public Health Nutr* 2009, **12**:267–83.
21. Verloigne M, Van Lippevelde W, Maes L, Brug J, De Bourdeaudhuij I: **Family- and school-based predictors of energy balance-related behaviours in children: a 6-year longitudinal study.** *Public Health Nutr* 2013, **16**:202–11.
22. Verloigne M, Van Lippevelde W, Maes L, Brug J, De Bourdeaudhuij I: **Family- and school-based correlates of energy balance-related behaviours in 10-12-year-old children: a systematic review within the ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project.** *Public Health Nutr* 2012, **15**:1380–95.
23. Verzeletti C, Maes L, Santinello M, Vereecken C a: **Soft drink consumption in adolescence: associations with food-related lifestyles and family rules in Belgium Flanders and the Veneto Region of Italy.** *Eur J Public Health* 2010, **20**:312–7.
24. Ferreira I, van der Horst K, Wendel-Vos W, Kremers S, van Lenthe FJ, Brug J: **Environmental correlates of physical activity in youth - a review and update.** *Obes Rev* 2007, **8**:129–54.
25. Van Der Horst K, Paw MJCA, Twisk JWR, Van Mechelen W: **A brief review on correlates of physical activity and sedentariness in youth.** *Med Sci Sports Exerc* 2007, **39**:1241–50.
26. Remmers T, Broeren SML, Renders CM, Hirasing RA, van Grieken A, Raat H: **A longitudinal study of children's outside play using family environment and perceived physical environment as predictors.** *Int J Behav Nutr Phys Act* 2014, **11**:76.
27. Pinard CA, Yaroch AL, Hart MH, Serrano EL, McFerren MM, Estabrooks PA: **Measures of the home environment related to childhood obesity: a systematic review.** *Public Health Nutr* 2012, **15**:97–109.
28. Spence A, Campbell K, Hesketh K: **Parental correlates of young children's dietary intakes: a review**. *Australas Epidemiol* 2010, **17**:17–20.
29. Jaime PC, Lock K: **Do school based food and nutrition policies improve diet and reduce obesity?** *Prev Med (Baltim)* 2009, **48**:45–53.
30. Vereecken C, Bobelijn K, Maes L: **School food policy at primary and secondary schools in Belgium-Flanders: does it influence young people's food habits?** *Eur J Clin Nutr* 2005, **59**:271–7.
31. Fung C, McIsaac J-LD, Kuhle S, Kirk SFL, Veugelers PJ: **The impact of a population-level school food and nutrition policy on dietary intake and body weights of Canadian children.** *Prev Med (Baltim)* 2013, **57**:934–40.

32. Herman CP, Polivy J: **Normative influences on food intake.** *Physiol Behav* 2005, **86**:762–72.
33. Bevelander KE, Anschütz DJ, Engels RCME: **Social modeling of food purchases at supermarkets in teenage girls.** *Appetite* 2011, **57**:99–104.
34. Salvy S-J, Kluczynski MA, Nitecki LA, O'Connor BC: **Peer influence on youth's snack purchases: a laboratory analog of convenience store shopping.** *Eat Behav* 2012, **13**:233–9.
35. Bell SL, Audrey S, Cooper AR, Noble S, Campbell R: **Lessons from a peer-led obesity prevention programme in English schools.** *Health Promot Int* 2014.
36. Campbell R, Starkey F, Holliday J, Audrey S, Bloor M, Parry-Langdon N, Hughes R, Moore L: **An informal school-based peer-led intervention for smoking prevention in adolescence (ASSIST): a cluster randomised trial.** *Lancet* 2008, **371**:1595–602.
37. Laska MN, Graham DJ, Moe SG, Van Riper D: **Young adult eating and food-purchasing patterns food store location and residential proximity.** *Am J Prev Med* 2010, **39**:464–7.
38. Caldwell EM, Miller Kobayashi M, DuBow WM, Wytinck SM: **Perceived access to fruits and vegetables associated with increased consumption.** *Public Health Nutr* 2009, **12**:1743–50.
39. Lucan SC, Mitra N: **Perceptions of the food environment are associated with fast-food (not fruit-and-vegetable) consumption: findings from multi-level models.** *Int J Public Health* 2012, **57**:599–608.
40. Cutler GJ, Flood A, Hannan P, Neumark-Sztainer D: **Multiple sociodemographic and socioenvironmental characteristics are correlated with major patterns of dietary intake in adolescents.** *J Am Diet Assoc* 2011, **111**:230–40.
41. Craig LC a, McNeill G, Macdiarmid JI, Masson LF, Holmes B a: **Dietary patterns of school-age children in Scotland: association with socio-economic indicators, physical activity and obesity.** *Br J Nutr* 2010, **103**:319–34.
42. De Coen V, Vansteelandt S, Maes L, Huybrechts I, De Bourdeaudhuij I, Vereecken C: **Parental socioeconomic status and soft drink consumption of the child. The mediating proportion of parenting practices.** *Appetite* 2012, **59**:76–80.
43. Hallström L, Vereecken CA, Labayen I, Ruiz JR, Le Donne C, García MC, Gilbert CC, Martínez SG, Grammatikaki E, Huybrechts I, Kafatos A, Kersting M, Manios Y, Molnár D, Patterson E, Widhalm K, De Vriendt T, Moreno LA, Sjöström M: **Breakfast habits among European adolescents and their association with sociodemographic factors: the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study.** *Public Health Nutr* 2012, **15**:1879–1889.
44. Johansen A, Rasmussen S, Madsen M: **Health behaviour among adolescents in Denmark: influence of school class and individual risk factors.** *Scand J Public Health* 2006, **34**:32–40.
45. Riediger ND, Shooshtari S, Moghadasian MH: **The influence of sociodemographic factors on patterns of fruit and vegetable consumption in Canadian adolescents.** *J Am Diet Assoc* 2007, **107**:1511–8.
46. Hanson MD, Chen E: **Socioeconomic status and health behaviors in adolescence: a review of the literature.** *J Behav Med* 2007, **30**:263–85.
47. Vereecken C, Dupuy M, Rasmussen M, Kelly C, Nansel TR, Al Sabbah H, Baldassari D, Jordan MD, Maes L, Niclasen BV-L, Ahluwalia N: **Breakfast consumption and its socio-demographic and lifestyle correlates in schoolchildren in 41 countries participating in the HBSC study.** *Int J Public Health* 2009, **54 Suppl 2**:180–90.
48. Bere E, van Lenthe F, Klepp K-I, Brug J: **Why do parents' education level and income affect the amount of fruits and vegetables adolescents eat?** *Eur J Public Health* 2008, **18**:611–5.
49. Hilsen M, van Stralen MM, Klepp K-I, Bere E: **Changes in 10-12 year old's fruit and vegetable intake in Norway from 2001 to 2008 in relation to gender and socioeconomic status - a comparison of two cross-sectional groups.** *Int J Behav Nutr Phys Act* 2011, **8**:108.
50. Magnée T, Burdorf A, Brug J, Kremers SPM, Oenema A, van Assema P, Ezendam NPM, van Genugten L, Hendriksen IJ, Hopman-Rock M, Jansen W, de Jong J, Kocken PL, Kroeze W, Kwak L, Lechner L, de Nooijer J, van Poppel MN, Robroek SJW, Schreurs H, van Sluijs EM, Steenhuis IJM, van Stralen MM, Tak NI, te Velde SJ, Vermeer WM, Wammes B, van Wier MF, van Lenthe FJ: **Equity-specific effects of 26 Dutch obesity-related lifestyle interventions.** *Am J Prev Med* 2013, **44**:e57–66.
51. Wijtzes AI, Jansen W, Jansen PW, Jaddoe VW V, Hofman A, Raat H: **Maternal educational level and preschool children's consumption of high-calorie snacks and sugar-containing beverages: mediation by the family food environment.** *Prev Med (Baltim)* 2013, **57**:607–12.
52. Black C, Moon G, Baird J: **Dietary inequalities: what is the evidence for the effect of the neighbourhood food environment?** *Health Place* 2013.
53. Larson NI, Story MT, Nelson MC: **Neighborhood environments: disparities in access to healthy foods in the U.S.** *Am J Prev Med* 2009, **36**:74–81.
54. Walker RE, Keane CR, Burke JG: **Disparities and access to healthy food in the United States: A review of food deserts literature.** *Health Place* 2010, **16**:876–84.
55. Gustafson A, Hankins S, Jilcott S: **Measures of the consumer food store environment: a systematic review of the evidence 2000-2011.** *J Community Health* 2012, **37**:897–911.
56. Winkler E, Turrell G, Patterson C: **Does living in a disadvantaged area entail limited opportunities to purchase fresh fruit and vegetables in terms of price, availability, and variety? Findings from the Brisbane Food Study.** *Health Place* 2006, **12**:741–8.
57. Cummins S, Smith DM, Aitken Z, Dawson J, Marshall D, Sparks L, Anderson AS: **Neighbourhood deprivation and the price and availability of fruit and vegetables in Scotland.** *J Hum Nutr Diet* 2010, **23**:494–501.
58. Cummins S, Macintyre S: **A Systematic Study of an Urban Foodscape: The Price and Availability of Food in Greater Glasgow**. *Urban Stud* 2002, **39**:2115–2130.
59. Latham J, Moffat T: **Determinants of variation in food cost and availability in two socioeconomically contrasting neighbourhoods of Hamilton, Ontario, Canada.** *Health Place* 2007, **13**:273–87.
60. Berthoud H-R: **The neurobiology of food intake in an obesogenic environment.** *Proc Nutr Soc* 2012, **71**:478–87.
61. Giskes K, van Lenthe F, Avendano-Pabon M, Brug J: **A systematic review of environmental factors and obesogenic dietary intakes among adults: are we getting closer to understanding obesogenic environments?** *Obes Rev* 2011, **12**:e95–e106.
62. Cohen DA, Babey SH: **Contextual influences on eating behaviours: heuristic processing and dietary choices.** *Obes Rev* 2012, **13**:766–79.
63. Kremers SPJ, de Bruijn G-J, Visscher TLS, van Mechelen W, de Vries NK, Brug J: **Environmental influences on energy balance-related behaviors: a dual-process view.** *Int J Behav Nutr Phys Act* 2006, **3**:9.
64. Bronfenbrenner u: **Ecology of the family as a context for human development: Research perspectives.** *Dev Psychol* 1986, **22**:723–744.

65. Bronfenbrenner u: *Making Human Beings Human: Bioecological Perspectives on Human Development*. Thousand Oaks: SAGE Publications; 2005.
66. Swinburn B, Egger G, Raza F: **Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity.** *Prev Med (Baltim)* 1999, **29**(6 Pt 1):563–70.
67. Gubbels JS, Van Kann DH, de Vries NK, Thijs C, Kremers SP: **The next step in health behavior research: the need for ecological moderation analyses - an application to diet and physical activity at childcare.** *Int J Behav Nutr Phys Act* 2014, **11**:52.
68. Pearson N, Ball K, Crawford D: **Predictors of changes in adolescents' consumption of fruits, vegetables and energy-dense snacks.** *Br J Nutr* 2011, **105**:795–803.
69. *Marmot Review. Fair Society, Healthy Lives*. London; 2010.
70. Davison KK, Jurkowski JM, Li K, Kranz S, Lawson HA: **A childhood obesity intervention developed by families for families: results from a pilot study.** *Int J Behav Nutr Phys Act* 2013, **10**:3.

summary

Samenvatting

Summary

Dietary behaviour is related to overweight and obesity, but also to several chronic diseases such as diabetes mellitus type II. Some dietary behaviour may reduce the risk of obesity or chronic diseases ('healthy' dietary behaviour), while other dietary behaviour may increase the risk of developing obesity or chronic diseases ('unhealthy' dietary behaviour). Given the high and increasing prevalence rates of overweight and obesity in the last decades, the adverse health consequences and, given the fact that childhood obesity tracks into adulthood, prevention of overweight and obesity among children is an important public health issue. However, to improve the dietary behaviour of children more insight is needed into the determinants of dietary behaviour among children.
Obesity and poor dietary intake are more common among children from parents with a low educational background. Reducing socio-economic inequalities in children's dietary behaviour is considered a key priority in public health. Therefore, it is important to identify modifiable determinants that may explain the socio-economic inequalities in children's dietary behaviour.

For many decades, research on the determinants of dietary behaviour focused on individual factors, such as attitude towards healthy dietary behaviour, intentions to change dietary behaviour or awareness of the importance of a healthy dietary behaviour. However, the trend of increasing obesity in many developed countries cannot be explained by such individual determinants alone. Therefore, it has been postulated that the environment may be a driving force in the increasing prevalence rates of obesity. Socio-ecological models describe the involvement of different types and levels of the environment and behaviour. Moreover, individuals interact with the environment in multiple micro-settings. For schoolchildren it is most likely that the micro-environment will mainly influence their dietary behaviour, including the home environment, school environment and neighbourhood. However, to date few studies have examined the elements of multiple environmental settings on children's dietary behaviour. Therefore, in this thesis we focus on determinants of the home, school and neighbourhood environment and the interaction between determinants in these environmental settings in relation to children's dietary behaviour. In addition, this thesis investigates whether such environmental determinants can explain socio-economic inequalities in children's dietary behaviour.

The aims of this thesis are:
- To investigate modifiable environmental determinants of dietary behaviour of primary school children aged 10-12 years.
- To investigate socio-economic inequalities in dietary behaviour of primary school children aged 10-12 years.
- To investigate whether modifiable environmental factors can explain socio-economic inequalities among primary school children aged 10-12 years.

Data for the studies described in this thesis were retrieved from the INPACT study. INPACT is the acronym for IVO Nutrition and Physical Activity Child cohorT. INPACT is a prospective, longitudinal study which started in the autumn of 2008 with a 4-year follow-up. The INPACT study was conducted among primary school children, and their parents, living in the southern part of the Netherlands. The study included four annual assessments, in which trained research assistants visited the schools to measure the weight and height of the children. Weight and height were used to calculate the children's body mass index ((BMI): weight (kg)/height (m^2)). Parents and children completed an annual questionnaire to measure (among other items) their dietary behaviour, factors of the home food environment, and parents' opinion on the school food policy. The studies presented in this thesis are based on parent and child-reported data, as well as height and weight as measured in the third and fourth wave of data collection (2010 and 2011). In addition, a one-time food store audit was conducted in the city of Eindhoven to measure neighbourhood characteristics, including the availability and the price of fruit and vegetables in the local shops. Finally, semi-structured interviews with school principals and teachers were conducted to collect data on the diet and activity-related school food policy of the primary schools.

Part one: Environmental determinants of children's dietary behaviour
Part one presents a set of studies examining the association between environmental determinants of the home, school and neighbourhood and children's dietary behaviour.

Chapter 2 reports on the association between parental perceptions of the local food shopping environment (price, availability and variety of fruit and vegetables in the shops), the home availability of fruit and vegetables, and children's consumption of fruit and vegetables. Home availability of fruit and vegetables was positively associated with children's fruit and vegetable intake. Furthermore, negative parental perceptions about the price, the availability and the variety of fruit in the shops were associated with a reduced availability of fruit at home. Unexpectedly, no associations were found between parental perceptions of the local food shopping environment and children's fruit and vegetable intake.

Chapter 3 explores the school food policy at Dutch primary schools. More specifically, it describes the presence, content and implementation of the school food policy. Furthermore, we investigated the schools' (i.e. principals and teachers) and parents' opinion on the school food policy (e.g. appreciation of the school food policy, and the role of schools in fostering healthy eating habits among children).
The majority (94.3%) of the 83 examined primary schools had a written food policy and informed parents about the food rules. Furthermore, in most schools (85.1%) education on nutrition was part of the school curriculum and most schools (68.9%) participated in specific nutrition projects. The majority of parents (76.5%) reported that they appreciated the school food policy and complied with the food rules. The majority of principals (74.0%) felt that they had only a supportive role to foster healthy eating behaviour among children and considered parents to be primarily responsible. About half of the parents felt that schools should play a role in encouraging healthy food habits among children.

Chapter 4 reports on the associations between parental factors (home availability of snacks and children's snack consumption rules) and peer sensitivity on children's snack consumption. It also explores whether a child's snack purchasing behaviour can explain the association between parental influence or peer sensitivity and children's snack consumption. No association was found between parental rules and children's snack consumption. Also, no association was found between parental rules and children's snack purchasing behaviour. Home availability of snacks was associated with children's snack consumption: children consumed more snacks when snacks were always available at home. Home availability of snacks was not associated with children's snack purchasing behaviour. Peer sensitivity was positively associated with both children's snack consumption and children's snack purchasing behaviour. A small part of the association between peer sensitivity and children's snack consumption was explained by children's snack purchasing behaviour.

Part two: Socio-economic inequalities in children's dietary behaviour and the influence of environmental determinants

The second part of this thesis focuses on socio-economic inequalities in the dietary behaviour of primary school children and investigates whether modifiable environmental factors can explain such inequalities in children's dietary behaviour.

Chapter 5 investigates socio-economic inequalities in healthy eating behaviours (fruit, vegetable and breakfast consumption) of children. Maternal educational level was used as an indicator for socio-economic status (SES). Furthermore, this study examines whether factors in the home food environment (parental intake of fruit, vegetables and breakfast; rules about fruit and vegetables, and home availability of fruit and vegetables) explain the association between maternal educational level and children's healthy eating behaviours (fruit, vegetable and breakfast consumption). Children from parents with a high SES consumed more fruit and vegetables per week and were also more likely to consume breakfast on a daily basis. All the studied home environmental factors contributed to the explanation of the association between children's SES and their healthy dietary behaviour. Moreover, the results indicate that socio-economic inequalities in fruit and vegetables consumption were explained, in particular, by parental intake of fruit and vegetables.

Chapter 6 explores the extent to which various types of micro-environmental factors explain socio-economic inequalities in children's consumption of sugar-sweetened beverages (SSBs) and energy-dense snacks. The environmental factors include home availability of SSBs and snacks, rules about snacks and SSBs and parental intake of SSBs and snacks, peer sensitivity, and children's snack purchasing behaviour. Maternal educational level was used as an indicator of the SES of the children. Children with a high SES had the lowest snack and SSB consumption compared to children with an intermediate and low SES. None of the studied micro-environmental factors explained the association between children's SES and their snack consumption. Home availability of SSBs and parental intake of SSBs partly explained the association between children's SES and their SSB consumption.

Chapter 7 investigates whether characteristics of the local food environment can contribute to socio-economic inequalities in children's fruit and vegetables consumption. Food store audits were conducted and matched with survey data of 292 children living in the city of Eindhoven. Children's SES was based on maternal educational level. For each child we determined the local food area around his/her house, defined as an 800-metre radius around the house. In the local food area we assessed: 1) the density of food stores, 2) the density of food stores per store type, 3) the mean variety of fruit and vegetables available in the food stores, and 4) the mean price of fruit and vegetables in the available food stores. Children with a low SES had a significantly lower fruit consumption compared to children with a high SES. No significant association was found between children's socio-economic background and their consumption of vegetables. We found no differences in the studied characteristics of the local food environment between children from various socio-economic backgrounds.

Finally, **Chapter 8** addresses the methodological issues, discusses the main findings, and makes some recommendations for future research and practice. Some methodological limitations of the studies described in this thesis (are among others) the use of cross-sectional data and the use of self-reported data. Results from the first part of this thesis show that factors related to the home food environment are associated with the dietary behaviour of 10-12 year old primary school children's and are, therefore, important targets for health interventions. Regarding the school food environment, it was concluded that the school food policy can be an important tool to foster healthy dietary behaviour among children. It was recommended that all primary schools should have a written school food policy. In addition, primary schools were advised to formulate clear rules about which food and beverages may be consumed during school time and how the school food policy will be enforced. For an effective school food policy it is also important that parents fully support the policy.

The second part of this thesis shows that children from a lower socio-economic background have the least favourable dietary behaviour. In addition, the results indicate that home environmental factors can explain socio-economic inequalities in children's dietary behaviour. However, as little is known about effective ways to improve the home food environment of children from lower socio-economic backgrounds, more research on this topic is warranted.

In conclusion, the magnitude and importance of environmental factors on dietary behaviour are generally context dependent. The results emerging from this thesis indicate that, for primary school children aged 10-12 years, factors in both the home food environment and the school food environment are the most important.

Samenvatting

Voedingsgedrag is gerelateerd aan overgewicht en verschillende chronische ziekten. Gezond voedingsgedrag kan de kans op overgewicht en chronische ziekten verminderen, terwijl ongezond voedingsgedrag de kans op overgewicht en chronische ziekten kan verhogen. In de afgelopen jaren is het percentage kinderen met overgewicht en met chronische aandoeningen zoals diabetes mellitus type 2 toegenomen. Een ongezonde voeding is hiervoor een belangrijke oorzaak. Met het oog op preventie van het ontstaan van chronische ziekten en obesitas op latere leeftijd, is het belangrijk om het voedingsgedrag van kinderen te verbeteren. Hiervoor is het belangrijk om inzicht te krijgen in invloeden op het voedingsgedrag van kinderen die veranderbaar zijn.
Vooral kinderen van ouders met een laag opleidingsniveau blijken vaker overgewicht en ongezond voedingsgedrag te hebben dan kinderen van ouders met een hoog opleidingsniveau. Het verkleinen van sociaaleconomische verschillen in het voedingsgedrag van kinderen is dan ook een belangrijk aandachtspunt in de publieke gezondheidszorg. In onderzoek naar determinanten van voedingsgedrag van kinderen is het daarom ook van belang om gedetailleerd inzicht te krijgen in veranderbare factoren die de sociaaleconomische verschillen in het voedingsgedrag van kinderen kunnen verklaren.

Lange tijd richtte onderzoek naar determinanten van voedingsgedrag zich vooral op individuele factoren, zoals de attitude ten aanzien van gezonde voeding, de intentie om gezonder te eten, of het bewustzijn van het belang van gezonde voeding. Omdat deze individuele factoren de stijging in de prevalentie van overgewicht van de laatste jaren niet konden verklaren, wordt er ook steeds meer onderzoek gedaan naar de invloed van omgevingskenmerken. Volgens sociaalecologische theorieën bestaat de omgeving uit meerder niveaus en types, die onderling met elkaar interacteren. Bovendien beschrijven deze theorieën een samenspel tussen menselijk gedrag en de verschillende omgevingstypes. Zo wordt het voedingsgedrag van basisschoolkinderen vooral beïnvloed door omgevingsfactoren op microniveau. Voor hen zijn de belangrijkste type omgevingen de thuisomgeving, de schoolomgeving en de buurtomgeving. Onderzoek naar factoren van diverse type omgevingen op het voedingsgedrag van kinderen is beperkt. Dit proefschrift richt zich dan ook op onderzoek naar factoren in de thuis-, school- en buurtomgeving op het voedingsgedrag van kinderen, en op de vraag of verschillen in deze factoren bijdragen aan de verklaring van sociaaleconomische verschillen in het voedingsgedrag van kinderen

De doelen van dit proefschrift zijn:
- Het identificeren van veranderbare omgevingsfactoren op het voedingsgedrag van 10-12 jarige schoolkinderen.
- Het identificeren van sociaaleconomische verschillen in het voedingsgedrag van 10-12 jarige schoolkinderen.
- Het onderzoeken of veranderbare omgevingsfactoren de sociaaleconomische verschillen in het voedingsgedrag van 10-12 jarige schoolkinderen kunnen verklaren.

De studies die in dit proefschrift worden beschreven maakten gebruik van data die verzameld zijn in de INPACT studie. INPACT is de afkorting van 'IVO Nutrition and Physical Activity Child cohorT'. INPACT is een prospectieve, longitudinale studie met 4 jaarlijkse metingen, de eerste meting vond plaats in 2008. De studie is uitgevoerd in Eindhoven en omgeving onder basisschoolkinderen en hun ouders. Tijdens de metingen bezochten getrainde onderzoeksassistenten de basisscholen om de kinderen te meten en te wegen (lengte, gewicht en buikomtrek). De gegevens over de lengte en het gewicht werden gebruikt om de body mass index (BMI, gewicht (kg) / lengte (m^2)) van het kind te bepalen. De ouders en kinderen vulden jaarlijks een vragenlijst in, waarin ondermeer vragen werden gesteld over het voedingsgedrag van de ouder en het kind, de aanwezigheid van eten en drinken in huis en de mening van ouders over het voedingsbeleid op school. De studies in dit proefschrift gebruikten alleen de gegevens die werden verzameld tijdens de derde en vierde meting (2010 en 2011). Daarnaast is er een systematische observatie van buurten uitgevoerd in de stad Eindhoven om gegevens te verzamelen over het aantal verkooppunten, de prijs en aanwezigheid van groenten en fruit in winkels. Als laatste zijn er semigestructureerde interviews afgenomen met de directeuren en leerkrachten van de deelnemende scholen over het voedingsbeleid op hun basisschool.

Deel 1: Omgevingsdeterminanten van het voedingsgedrag van kinderen
Het eerste deel van dit proefschrift richt zich op omgevingsdeterminanten van de thuis-, school- en buurtomgeving die kunnen samenhangen met het voedingsgedrag van kinderen.

In **hoofdstuk 2** worden de resultaten gerapporteerd van een cross-sectionele studie naar de relatie tussen de perceptie van ouders over de buurtomgeving (prijs, aanwezigheid en variatie van groenten en fruit in winkels), de aanwezigheid van groente en fruit in huis en de consumptie van groente en fruit van kinderen. De aanwezigheid van groente en fruit in huis was positief geassocieerd met de groente- en fruitinname van kinderen. Een negatieve perceptie van ouders over de prijs, de aanwezigheid en de variatie van fruit in winkels hing samen met een lagere aanwezigheid van fruit in huis. Tegen de verwachting in, werd er geen associatie gevonden tussen de perceptie van ouders over de buurtomgeving en de groente- en fruitconsumptie van kinderen.

Hoofdstuk 3 richt zich op het voedingsbeleid op Nederlandse basisscholen. De studie beschrijft de aanwezigheid, inhoud en uitvoering van het voedingsbeleid. Bovendien onderzoekt de studie de mening van de school (leerkrachten en directeuren) en de ouders over het voedingsbeleid. De meerderheid (94,3%) van de 83 onderzochte basisscholen heeft een voedingsbeleid en informeert de ouders over dit beleid. Bovendien bleek het thema 'voeding' onderdeel van het curriculum van de meeste scholen (85,1%) en participeerde de meerderheid van de scholen (68,9%) in projecten over gezonde voeding. De meeste ouders (76,5%) gaven aan dat zij het voedingsbeleid van de school waardeerden en dat zij zich aan het beleid hielden. De meeste directeuren (74,0%) waren van mening dat de school een ondersteunende rol heeft bij het aanleren van gezond voedingsgedrag van kinderen en vinden dat de ouders hiervoor hoofdverantwoordelijk zijn. De helft van de ouders rapporteerde dat de school een prominentere rol kan spelen bij het bevorderen van gezond voedingsgedrag van kinderen.

In **hoofdstuk 4** wordt het verband tussen de invloed van ouders (aanwezigheid van snacks in huis en regels over de snackconsumptie van het kind) en vrienden op het snackgedrag van kinderen onderzocht. Ook wordt onderzocht of de zakgeldbesteding (kopen van snacks van het zakgeld) van kinderen de relatie tussen de invloed van ouders/vrienden en het snackgedrag van het kind kan verklaren. Regels van ouders over de snackconsumptie van kinderen hingen niet samen met de snackconsumptie van kinderen. Ook werd er geen verband gevonden tussen de regels van ouders over de snackconsumptie en de zakgeldbesteding van kinderen. De aanwezigheid van snacks in huis was wel geassocieerd met het eten van meer snacks door kinderen. De aanwezigheid van snacks in huis was niet geassocieerd met de zakgeldbesteding van kinderen. Kinderen die gevoelig zijn voor de sociale druk van hun vrienden consumeerden meer snacks en kochten meer snacks van hun zakgeld. Een klein deel van het verband tussen de invloed van vrienden en de snackconsumptie van kinderen werd verklaard door de zakgeldbesteding van kinderen.

Deel 2: Sociaaleconomische verschillen in het voedingsgedrag van kinderen en de invloed van omgevingsdeterminanten

Het tweede deel van het proefschrift onderzoekt sociaaleconomische verschillen in het voedingsgedrag van kinderen. Daarnaast wordt er onderzocht of deze verschillen verklaard kunnen worden door omgevingsdeterminanten.

Hoofdstuk 5 onderzoekt of er sociaaleconomische verschillen zijn in het gezonde voedingsgedrag van kinderen, en richt zich hierbij specifiek op ontbijten, groente- en fruitconsumptie. Daarnaast wordt er onderzocht of factoren uit de thuisomgeving (consumptie van groente, fruit en ontbijten door ouders, regels over de consumptie van groente en fruit, en de aanwezigheid van groente en fruit in huis) de relatie tussen sociaaleconomische status (SES) en voedingsgedrag van het kind verklaart. De SES van het kind is bepaald op basis van het opleidingsniveau van de moeder. Uit de resultaten van deze studie bleek dat kinderen met een hoge SES meer groente en fruit eten en vaker dagelijks ontbijten. Alle onderzochte factoren uit de thuisomgeving droegen bij aan de verklaring van de relatie tussen SES en het voedingsgedrag van het kind. De sociaaleconomische verschillen in de groente- en fruitconsumptie werden voornamelijk verklaard door de groente- en fruitconsumptie van de ouders.

In **hoofdstuk 6** wordt onderzocht of omgevingsdeterminanten het verband tussen de SES van kinderen en de consumptie van frisdranken en snacks van kinderen kunnen verklaren. De SES van het kind werd ook in deze studie bepaald op basis van het opleidingsniveau van de moeder. Onderzochte omgevingsdeterminanten waren de aanwezigheid van snacks en frisdrank in huis, regels over de consumptie van snacks en frisdrank, consumptie van snacks en frisdrank door ouders, invloed van vrienden, en de zakgeldbesteding van kinderen (kopen van snacks van zakgeld). De consumptie van snacks en frisdrank was het laagst bij kinderen met een hoge SES. Geen van de onderzochte omgevingsdeterminanten verklaarden het verband tussen de SES en het snackgedrag van het kind. Het verband tussen de SES van het kind en zijn frisdrankconsumptie werd gedeeltelijk verklaard door de aanwezigheid van frisdrank in huis en de frisdrankconsumptie van de ouder.

In **hoofdstuk 7** staat de buurtomgeving centraal. In deze studie wordt onderzocht of sociaaleconomische verschillen in de groente- en fruitconsumptie van kinderen verklaard kan worden door kenmerken uit de buurtomgeving. Voor deze studie zijn gegevens van de buurtobservatie in Eindhoven gekoppeld aan de gegevens uit de vragenlijst van 292 kinderen woonachtig in Eindhoven. De SES van het kind is bepaald op basis van het opleidingsniveau van de moeder. Voor elk kind is zijn/haar directe buurtomgeving bepaald (straal van 800 meter rond het huis van het kind). In de directe buurtomgeving zijn de volgende buurtkenmerken gemeten: 1) het aantal verkooppunten van groenten en fruit, 2) het 'type' verkooppunten (bijvoorbeeld supermarkt, groenteboer), 3) de gemiddelde variatie van groenten en fruit in winkels, 4) de gemiddelde prijs van groenten en fruit in winkels. Kinderen met een lage SES consumeerden significant minder fruit dan kinderen met een hoge SES. Er werd geen significant verband gevonden tussen de SES van kinderen en hun groenteconsumptie. Deze studie vond ook geen verschillen in de bestudeerde buurtkenmerken tussen kinderen met een lage, middelhoge of hoge SES.

Het laatste hoofdstuk (**hoofdstuk 8)** bediscussieert methodologische overwegingen, integreert de resultaten uit de verschillende studies en bespreekt de wetenschappelijke en praktische implicaties van dit proefschrift. Methodologische beperkingen van de studies beschreven in dit proefschrift zijn onder andere het cross-sectionele design van de studies en het gebruik van vragenlijsten waarin ouders en kinderen hun eigen gedrag rapporteerden.
Uit het eerste deel van dit proefschrift kan geconcludeerd worden dat verschillende factoren uit de thuisomgeving samenhangen met het voedingsgedrag van 10-12 jarige basisschoolkinderen. Dit zijn dan ook belangrijke determinanten waarop gezondheidsinterventies zich kunnen richten. Ten aanzien van de schoolomgeving kan geconcludeerd worden dat het voedingsbeleid van scholen een belangrijk middel kan zijn om gezond voedingsgedrag bij het aanleren van gezond voedingsgedrag bij kinderen. Een aanbeveling is dan ook dat alle Nederlandse basisscholen voedingsbeleid opstellen, dit schriftelijk vastleggen waarbij duidelijk wordt aangegeven welke voedingsmiddelen tijdens schooltijd genuttigd mogen worden. Om te zorgen dat het beleid ook effect zal hebben op het voedingsgedrag van kinderen zijn ook de ouders; zij moeten het beleid steunen en naleven.
Uit het tweede deel van dit proefschrift komt naar voren dat kinderen met een lagere SES ongezonder voedingsgedrag hebben dan leeftijdgenoten met een hogere SES. Sociaaleconomische verschillen in het voedingsgedrag van kinderen kan deels worden verklaard door factoren uit de thuisomgeving. Dit is belangrijke informatie voor gezondheidsinterventies. Echter, meer informatie over hoe de thuisomgeving van kinderen met een lage SES gezonder kan worden gemaakt is noodzakelijk.
Tot slot, de invloed van omgevingsdeterminanten op het voedingsgedrag zijn contextafhankelijk. De bevindingen uit dit proefschrift laten zien dat voor 10-12 jarige Nederlandse basisschoolkinderen factoren uit de thuisomgeving en schoolomgeving het belangrijkste zijn.

Dankwoord

Na 2,5 bij het IVO aan het INPACT-onderzoek te hebben gewerkt en bijna 2 jaar in mijn vrije tijd te hebben gezwoegd is het zover: Het is af! Dit was nooit gelukt zonder de steun en hulp uit mijn omgeving die ik bij deze graag wil bedanken!

Allereerst, Dike en Miranda. Jullie hebben mij bij het IVO de kans gegeven om het lopende INPACT-onderzoek voort te zetten en nog 2 jaar data te verzamelen. Jullie hebben mij altijd gesteund en de mogelijkheden gegeven die ik nodig had om mijn promotieonderzoek te kunnen afronden. Heel erg bedankt hiervoor! Dike, ik heb veel bewondering hoe jij je overvolle schema weet te organiseren. Je had altijd tijd om mijn stukken nauwkeurig door te lezen, ook al stuurde ik deze soms pas op het allerlaatste moment naar je op. Jij nam de stukken zeer kritisch door en had behalve de rode draad ook nog oog voor de details. Dank voor de fijne samenwerking en begeleiding!
Carola, de eerste jaren was jij mijn dagelijks begeleider. De samenwerking met jou was heel erg fijn en ik heb veel van je geleerd. Jij bent zeer strak georganiseerd, precies en hebt oog voor alle details. Je houdt van heldere en bondige formulering en duidelijk gestructureerde stukken; een verademing in het onderzoek! Als ik het even niet meer wist of zag zitten, dan hoefde ik maar even bij je langs te gaan en je zette me weer op het juiste spoor. Ik had je graag als copromotor hier gezien vandaag, maar ook op afstand was je betrokken en heb je mij geholpen om de laatste artikelen af te ronden. Dank voor alles!
Frank, jij bent later in mijn promotietraject ingestroomd. In het begin, was het voor ons beide dan ook wennen en aftasten. Wat hadden we aan elkaar, wat kon jij inbrengen in de al reeds gelegde fundering voor mijn proefschrift? Uiteindelijk nog heel veel! Je kennis uit het veld over voeding en de omgeving is zeer groot en was erg welkom. Ook je statistische kennis was van grote toegevoegde waarde voor mijn onderzoek. Daarnaast was je hulp bij het schrijven van de inleiding, discussie en stellingen van mijn proefschrift ook zeer waardevol. Heel erg veel dank dat je op de al lopende trein bent gestapt en mij naar het eindstation hebt begeleid.

Dan Gerda, je was al wat verder met je promotieonderzoek, had veel meer onderzoekservaring en was altijd heel erg bereid om mij met raad en daad bij te staan. Ik vind het dan ook ontzettend leuk dat jij op al mijn artikelen als coauteur staat!

De promotiecommissie dank ik voor lezen en beoordelen van mijn proefschrift. Alle ouders, kinderen, leerkrachten en directeuren; bedankt voor jullie deelname aan het INPACT-onderzoek. Zonder jullie inzet was het INPACT-onderzoek nooit geslaagd.
Bij het INPACT-onderzoek waren ook twee adviseurs betrokken: Anke Oenema en Jantine Schuit. Jullie kennis, scherpe blik en oog voor details hebben geholpen bij het tot stand komen van twee studies. Dank hiervoor! Jantine, dit heeft geresulteerd in een mooie publicatie over het voedingsbeleid op Nederlandse basisscholen. Anke, hopelijk resulteert onze samenwerking ook nog in een publicatie.

Diverse onderzoeksassistenten en stagiaires hebben mij geholpen bij het verzamelen van alle data. Een kleine greep uit de werkzaamheden: ruim 1800 kinderen meten en wegen, vragenlijsten afnemen, op de fiets door Eindhoven alle winkels die groenten en/of fruit verkopen lokaliseren, prijzen en soorten groenten en fruit noteren, met een passer op een plattegrond van Eindhoven voor ruim 200 kinderen bepalen wat hun directe woonomgeving is, en meer dan 70 directeuren en leerkrachten interviewen over het voedingsbeleid op hun school. Wat was het een hoop werk, dank voor jullie geweldige inzet!

Caspar Looman, dank voor je statistische hulp. Laraine Visser en David Alexander dank voor de correcties op de Engelse grammatica. Monique Pouw dank voor het ontwerpen en opmaken van mijn proefschrift, geheel in de 'INPACT' stijl.

Dank aan alle (oud)collega's bij het IVO. Wat heb ik een fijne tijd bij jullie gehad. Ik heb met vele van jullie mogen samenwerken of een kamer mogen delen. Lieve Cindy en Ineke, jullie noem ik even apart; niet alleen bedankt voor jullie gezelligheid maar ook voor de hulp bij het organiseren van alle praktische zaken die bij het opzetten en uitvoeren van onderzoek komen kijken!

Mijn huidige collega's bij ZonMw. Dank voor jullie interesse in mijn promotieonderzoek en de tips die ik van een aantal van jullie kreeg!

Lieve vrienden, fijn dat jullie interesse in mijn proefschrift toonden! En de broodnodige afleiding was meer dan welkom! Mijn twee beste vriendinnetjes én paranimfen wil ik nog even speciaal noemen:
Lieve Ilse, we kennen elkaar al ruim 10 jaar. We hadden en hebben altijd de grootste lol (en niemand die er iets van snapt), maar ook tijdens enkele hele moeilijke periodes was jij er voor mij. We zien en spreken elkaar wat minder door de fysieke afstand, desondanks is de band tussen ons nog steeds ijzersterk. Na alles wat we samen hebben meegemaakt, weet ik dat ik met jouw steun alles aankan. Ik ben dan ook heel erg blij met jou als paranimf!
Lieve Caroline, of moet ik zusje zeggen? Ja, we worden vaak voor zussen aangezien! We kennen elkaar van onze studietijd aan de VU, maar zijn gek genoeg pas echt vriendinnen geworden sinds we niet meer bij elkaar om de hoek wonen. Ook jij bent er altijd voor mij en we kunnen heerlijk lachen en genieten van een goed feestje, wijntje, heerlijk eten of een bezoekje aan musea. Vanaf het eerste moment was je heel erg geïnteresseerd in mijn promotieonderzoek. Ik vind het dan ook heel erg leuk dat jij mij als paranimf bijstaat.

Ook alle familieleden, dank voor jullie interesse. Ome Johan en Tante Will; bedankt voor de fijne gesprekken over o.a. mijn proefschrift. Ik vind dit ontzettend fijn en het heeft mij erg geholpen.

Lieve schoonfamilie, wat heb ik het met jullie getroffen. Dank voor jullie interesse, wijze raad en de broodnodige ontspanning. De 'Makkinje-tak': Lieve Ingeborg en Jaap, dank voor jullie steun en interesse in mijn onderzoek en voor alle gezellige momenten. Ingeborg, wat fijn dat ik altijd bij je terecht kan en dat we de beste gesprekken voeren tot diep in de nacht als Jaap en Bart weer gaan biljarten. Daarnaast heb je een fantastische speelgoedwinkel 'De Regenboog', en ik weet zeker dat de INPACT-kinderen de

door jouw geadviseerde cadeautjes om hen te bedanken voor hun deelnamen aan het onderzoek heel erg leuk vonden! Marion, dank voor de krantenknipsels die je me trouw toestuurt als je iets interessants over voeding in de krant ziet staan! Anne, dank voor je interesse, luisterend oor en de leuke uitjes (musicals, toneelstukken en etentjes). Dan de 'van Wezel-van Agt' kant: Lieve Haje en Eugenie, bedankt voor jullie interesse, steun en wijze raad. Jullie hulp met het schrijven van sollicitatiebrieven was de eerste stap voor dit proefschrift. Ook wil ik jullie bedanken voor alle fijne momenten samen met heel veel gezelligheid en humor (erg belangrijk om het schrijven van een proefschrift vol te houden!). Lieve schoonbroer en zussen ook jullie bedankt voor jullie interesse en alle gezellige familieavondjes!

En dan mijn lieve broer en zussen, ook jullie wil ik bedanken! Yvonne, als klein meisje keek ik erg tegen je op. Je bent 10 jaar ouder en dat gestudeer van je vond ik razend interessant. En nu staat je kleine zusje dan hier!
René, mijn groet broer. Jij bent juist wat minder van het studeren, maar wel van heel hard werken.
Ik zeg het eigenlijk nooit, maar ik ben zo blij met onze band! Yvonne de Wit, wat heb ik toch een leuke schoonzus! En Linn en Noor, jullie zijn mijn allerliefste nichtjes! Komen jullie snel weer eens bij ons logeren?
En dan mijn lieve zus Karin, woonachtig in het verre Nieuw-Zeeland. Naar een moeilijke weg ben je eindelijk 'geland' in Te Anua. Zo fijn om te zien en horen dat je daar op je plek zit. Fijn dat je altijd voor mij klaar staat en me altijd steunt. Afstand zegt niets over onze band! En wat ben ik ongelofelijk blij dat jij bij mijn promotie aanwezig bent!

Lieve Papa, jij hebt mij altijd gestimuleerd om zo lang mogelijk te studeren. Dat heb ik gedaan, en dat heeft erin geresulteerd dat ik vandaag mijn proefschrift mag verdedigen. Ik weet dat jij ongelofelijk trots op mij bent, maar ik ben ook heel trots op jou. Mijn doorzettingsvermogen (wat voor het behalen van een proefschrift essentieel is) komt zeker van jou, dit boekje is dan ook voor jou! Lieve Hilde, jij bent als een tweede moeder voor mij. Dank voor alles wat je voor mij hebt gedaan en nog steeds doet. Fijn om te weten dat jullie er altijd zijn.

Als laatste, lieve Bart. Jouw steun en geloof in mij heeft er mede voor gezorgd dat het maar mooi af is! Het is moeilijk om in woorden uit te drukken wat jij voor mij betekent, maar dit komt aardig in de buurt: You are everything I need and more!

Wilke

Curriculum vitae

Wilke van Ansem was born on 25 April 1986 in Maarheeze. In 2003 she completed secondary education at the Bisschoppelijk College, Weert. Subsequently, she started the bachelor Nutrition and Dietetics at the Hogeschool van Arnhem and Nijmegen. After obtaining her Bachelor degree in 2007, she continued her education with the study Health Sciences at the VU University in Amsterdam.
She obtained her Master of Science degree in 2009 with the specializations 'Prevention and Public Health' and 'Infectious Diseases and Public Health'. The work for her Master's thesis was performed at the Academische Werkplaats AMPHI, where she started to work as a research assistant after her graduation. She was involved in a research project about the vaccination coverage and vaccination decision-making processes in the orthodox Protestant community.

From May 2010 until December 2012 she worked as a junior researcher at the IVO addiction research institute in Rotterdam. During this period she was involved in the INPACT project which resulted in this PHD- thesis on the influence of environmental determinants on children's dietary behaviour.
From May 2013 until September 2013 she worked as a researcher at IVO and was involved in several research projects (e.g. effect evaluation of treatment for alcohol addiction, sexual aggression among youth in Rotterdam). Since 2014 she works at the Netherlands Organisation for Health Research and Development (ZonMw). First at the department of science and innovation were she was involved in several public-private partnership projects. At this moment she works at the department of prevention and is involved in the Joint Programme Initiative 'Healthy Diet for a Healthy Life' (JPI HDHL).

List of publications

2014

Van Ansem WJC, Schrijvers CTM, Rodenburg G, van de Mheen D: **Maternal educational level and children's healthy eating behaviour: role of the home food environment (cross-sectional results from the INPACT study).** *Int J Behav Nutr Phys Act* 2014, **11**:113.

Van Ansem WJC, van Lenthe FJ, Schrijvers CTM, Rodenburg G, van de Mheen D: **Socio-economic inequalities in children's snack consumption and sugar-sweetened beverage consumption: the contribution of home environmental factors.** *Br J Nutr* 2014, **112**:467–76.

2013

Van Ansem WJC, Schrijvers CTM, Rodenburg G, Schuit AJ, van de Mheen D: **School food policy at Dutch primary schools: room for improvement? Cross-sectional findings from the INPACT study.** *BMC Public Health* 2013, **13**:339.

Van Ansem WJC, Schrijvers CTM, Rodenburg G, van de Mheen D: **Is there an association between the home food environment, the local food shopping environment and children's fruit and vegetable intake? Results from the Dutch INPACT study.** *Public Health Nutr* 2013, **16**:1206–14.

2012

Ruijs WLM, Hautvast JLA, van IJzendoorn G, van Ansem WJC, Elwyn G, van der Velden K, Hulscher MEJL: **How healthcare professionals respond to parents with religious objections to vaccination: a qualitative study.** *BMC Health Serv Res* 2012, **12**:231.

Ruijs WLM, Hautvast JLA, van Ijzendoorn G, van Ansem WJC, van der Velden K, Hulscher MEJL: **How orthodox protestant parents decide on the vaccination of their children: a qualitative study.** *BMC Public Health* 2012, **12**:408.

Ruijs WLM, Hautvast JLA, van Ansem WJC, Akkermans RP, van't Spijker K, Hulscher MEJL, van der Velden K: **Measuring vaccination coverage in a hard to reach minority.** *Eur J Public Health* 2012, **22**:359–64.

Submitted

Van Ansem WJC, , Schrijvers CTM, Rodenburg G, van de Mheen D (submitted). **Children's snack consumption: role of parents, peers and child snack-purchasing behaviour. Results from the INPACT study.**

Van Ansem WJC, van Lenthe FJ, Schrijvers CTM, Rodenburg G, Oenema A, van de Mheen D (submitted). **Characteristics of the local food environment: Can they explain socio-economic disparities in children's fruit and vegetable consumption? Results from the INPACT study.**

IVO
Heemraadssingel 194
3021 DM Rotterdam
T 010 425 33 66
F 010 276 39 88
Secretariaat@ivo.nl
www.ivo.nl