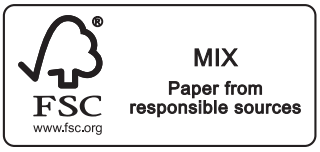
Promoting Healthy Behaviours among Children Living in Disadvantaged Neighbourhoods

Development and evaluation of a Social Marketing intervention: the 'Water Campaign'

Vivian M.J. Kruitwagen – van de Gaar



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This study is part of the Dutch project CIAO, which stands for Consortium Integrated Approach Overweight. Within CIAO, several studies are conducted investigating the different components of the EPODE approach. In this thesis, we focused on the pillar 'Social Marketing'.

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Bevorderen van gezond gedrag bij kinderen in achterstandswijken

Ontwikkeling en evaluatie van een Sociale Marketing interventie: de 'Water Campagne'

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THERE ARE TWO
GIFTS WE SHOULD
GIVE OUR CHILDREN;
ONE IS ROOTS, AND
THE OTHER IS WINGS.

W. Hodding Carter II

Voor mama...

Contents

1

General introduction

This first chapter gives a short overview on childhood overweight and possible effective solutions to promote a healthy behaviour among children, more specifically by using integrated approaches. Some examples of integrated approaches as well as the Dutch Consortium Integrated Approach Overweight (CIAO) are introduced. Finally, the concept and use of Social Marketing is described, with an introduction to the intervention under study in this thesis: the 'Water campaign'. The research questions and an outline of this thesis are presented at the end of the chapter.

Childhood overweight

Unhealthy behaviours and subsequent overweight and obesity in children is a growing problem worldwide, especially for children living in disadvantaged neighbourhoods [1-5]. Overweight in children is linked to numerous adverse health outcomes, immediate and later in life, making the high worldwide prevalence of childhood overweight a major public health concern [6-8]. The number of overweight children is not declining, at best it is levelling off [5, 9-15]. Unfortunately, prevention efforts have so far yielded disappointing results [16]. Therefore, the need for effective interventions aimed at supporting a healthy behaviour in children is still urgent.

To optimize overweight prevention, there is a strong call for integrated approaches that bring about effective and sustainable interventions aiming at multiple ecological levels [17-24]. The term 'integrated' implies health promoting interventions that simultaneously target individual determinants (e.g., motivation to drink water instead of sugar-sweetened beverages (SSB)) and environmental determinants (e.g., reducing the relative price of water) [25-28]. Research indicates that these integrated approaches should focus on multiple behaviours of children (and their family), such as consumption of snacks and SSB, physical activity and play [23, 29].

Integrated approaches: EPODE and JOGG

A successful example of such an integrated overweight prevention approach is the French EPODE Project ('Ensemble Prévenons l'Obésité Des Enfants', meaning 'Together Let's Prevent Childhood Obesity') [30]. The successes of EPODE were found to be based on four 'pillars' (i.e., effective elements) [30, 31]:

1) Political commitment: a healthy weight for youth has an important place in the programme of the College of Mayor and Aldermen. There must be strong political will at local level (as well as regional and national level); engagement of the mayor or leader of the local community is crucial.
2) Science- and evidence-based: the activities are monitored, evaluated and adjusted if necessary. There is a need to evaluate and have evidence, especially for the community, and also for the funders, who need to know if their investment is worthwhile.
3) Use of Social Marketing: by engaging in dialogue with the audience, the programme will better connect and fit to the world of children and young people.
4) Public-private partnership: involvement of local businesses and public parties. Behaviour change, individual or environmental, takes a long time, so funding must be sustainable. The best model to ensure sustainability is a combination of public and private resources.

In the Netherlands, the EPODE project is translated to JOGG ('Jongeren op Gezond Gewicht', meaning 'Youth at a Healthy Weight'). The Dutch JOGG was founded in 2009 and is financed by the Dutch Ministry of Health. The organisation behind JOGG strives to realize a society in which all children and young people live, learn, play and work in an environment in which a healthy behaviour is the most natural thing in the world (i.e., in a healthy society the healthy choices are the most obvious choices)[32]. Municipalities, small or large, can join the JOGG movement. In 2016, more than 100 municipalities joined JOGG and implemented the JOGG approach [32]. In the Netherlands, the JOGG organisation provides municipalities with tools to get more young people on a healthy weight, using co-creation with local environment and local stakeholders to establish a sustainable and healthy community for children to grow up in. Besides the four pillars of EPODE, JOGG has added another pillar relevant for the Dutch situation, namely:

5) Connecting prevention and cure: professionals identify overweight and jointly tailored services (preventive or treatment-oriented) are available. Because of intensified collaboration in the (preventive) health care chain the overweight or obese child is or can be better identified and will receive the best fit of services[32].

To gain more insight into the effectiveness of Dutch integrated approaches such as JOGG, a national research consortium was established: the Consortium Integrated Approach Overweight (CIAO).

CIAO: national research consortium

CIAO was established to improve our understanding of JOGG's integrated approach aimed at preventing childhood overweight [20]. The consortium is a collaboration between academic institutions, community health services, local authorities and other relevant sectors ('academic collaborations'). The aim of the consortium is to provide elements of a coherent integrated multi-sectoral approach towards overweight prevention based on the principles of the EPODE approach [20]. Since the EPODE project seems to be promising [15, 33], CIAO mainly investigated the successes of the on EPODE based JOGG approach in the Netherlands. This thesis discusses one of the pillars, namely the use of 'Social Marketing'.

Social Marketing

Social Marketing is defined as: "the adaptation of commercial marketing technologies to programmes designed to influence the voluntary behaviour of target audiences to improve their personal welfare and that of society of which they are a part"[34]. French states it this way: "Social Marketing aims to change voluntary behaviour by taking the needs and wishes of the target audience as the starting point and from there trying to understand how best to promote the desired behaviour using an integrated, tailored approach"[35].

Social Marketing has led to successful childhood overweight prevention interventions [27, 28, 36-40]. A major strength of Social Marketing is its 'client-oriented' focus, resulting not only in tailored interventions, but also in improved intervention reception and acceptance [30, 35, 41]. Since Social Marketing is regarded a promising strategy to achieve behaviour change, experts from the field of policy, intervention development and research recommend to implement Social Marketing in the development of interventions aimed at prevention of childhood overweight [37, 40, 42].

In recent years, the involvement of key stakeholders at various ecological levels has been integrated in Social Marketing approaches [35, 43]. This is in line with best practice principles for community-based interventions as described by King in her review of effective overweight prevention programmes [44]. An example of such an intervention which has

been developed using Social Marketing and that incorporates the community is the 'Water Campaign'.

The Water Campaign

In the last part of this thesis, the intervention under study is the 'Water Campaign'. The 'Water Campaign', developed with Social Marketing, aimed to decrease the consumption of SSB among primary school children (aged 6 to 12 years old) by promoting the intake of water; it targeted both children and their parents (primarily mothers) through activities at school and in the neighbourhood (i.e., school- and community-based)[45, 46]. The campaign was developed as an enrichment of an existing school-based programme 'Enjoy Being Fit!'[47]. The campaign focused on parents' involvement in encouraging positive behaviour change with regard to their children's behaviours. In addition, community involvement was achieved by the participation of local stakeholders.

Besides Social Marketing, Intervention Mapping (i.e., a systematic method to develop health promotion interventions [48]) was used to develop the 'Water Campaign'[46]. Following the Social Marketing guidelines by French [35], desk research and focus-group interviews were applied to identify specific target segments and target behaviours. Based on these results, the local government intervention-development team decided to focus the intervention on reducing SSB intake and to focus on Moroccan and Turkish families [49]. These families constitute a large part of the population on the schools of the 'Enjoy Being Fit!' programme and are disproportionately affected by childhood overweight [49].

In 2011, this campaign was implemented in two multi-ethnic, disadvantaged neighbourhoods in Rotterdam, the Netherlands. By encouraging the children to consume more water, the 'Water Campaign' intended to reduce children's SSB intake. Although the intervention was tailored to, pre-tested with and developed for children and mothers from these ethnic minorities, the 'Water Campaign' was delivered to all children (and their families) attending schools in and/or living in the two 'Water Campaign' neighbourhoods.

Research questions addressed in this thesis

This thesis aims to contribute to the development, implementation and evaluation of interventions aimed to promote healthy behaviours among children living in disadvantaged neighbourhoods. Specifically, the development and effectiveness of the 'Water Campaign', a Social Marketing intervention is described. In three subsequent parts, the following research questions are studied:

For part I: Assessing nutritional behaviour of children

1) How good is the level of agreement between children's report of their own nutritional behaviour compared to reports of their parents and observed data? (chapter 2)

For part II: Determinants of health behaviours among children

2) Which family and home-related factors are associated with health behaviours among children? (chapters 3 & 4)
3) Which parenting styles and parenting feeding styles are associated with health behaviours among children? (chapter 5)

For part III: Development and effect of interventions promoting healthy behaviours among children

4) Which interventions on improving healthy behaviours of disadvantaged children in Europe are effective? (chapter 6)
5) How can Social Marketing be used in intervention development aimed to promote healthy behaviours among children? (chapter 7)
6) How effective is the 'Water Campaign' in reducing the child's intake of SSB after one year? (chapter 8)

Outline of the studies presented in this thesis

In this thesis, 7 studies are described in three subsequent parts. In the first part, a study assessing nutritional behaviour of children is described: **chapter 2**. A study on differences in reporting by children and parents regarding the child's water, fruit and SSB intake is described. In addition, the study in chapter 2 also describes the agreement between observations and child's reports of break-time foods.

The second part of this thesis describes studies on determinants of health behaviours among children. Insights into these determinants among young and ethnically diverse populations may help contribute to intervention development and thereby to improved reach and intervention effectiveness. In **chapter 3**, a study on the influence of socio-demographic characteristics, cognitive, environmental and habitual factors (e.g., parental beliefs, parenting practices) on children's SSB consumption is presented. In **chapter 4**, the influence of socio-demographic characteristics and family and home-related determinants (e.g., parental beliefs, parenting practices) on child's snack intake are evaluated. Both in chapters 3 and 4, these associations were explored within ethnic subgroups. In **chapter 5**, the influence of parenting styles and feeding styles on snacking behaviour in children is described.

In the third part of this thesis, studies are presented on the development and effectiveness of interventions aimed at promoting healthy behaviours among children. In **chapter 6**, a systematic review is presented evaluating the effects of interventions aiming to improve healthy behaviours among socially disadvantaged children in Europe. In **chapter 7** is described how the 'Water Campaign' is developed using Social Marketing in combination with Intervention Mapping. In **chapter 8**, the effects of the 'Water Campaign' on children's SSB consumption are evaluated. This controlled trial showed positive effects in reducing the intake of SSB among children when promoting the consumption of water.

In **chapter 9**, the results of the studies are summarized and interpreted alongside the literature. Strengths and limitations of the studies are discussed. Recommendations for future research are made and implications for practice and policy are presented. Finally, an overall conclusion is drawn. Table 1 provides an overview of the studies presented in this thesis.

Table 1: Overview of the studies presented in this thesis

Chapter	Study design	n	Sub-groups	Determinants	Main outcomes
2	Cross-sectional study	682	n/a	Water, fruit, SSB and break-time foods (i.e., sandwiches, fruit/vegetables and snacks)	Agreement between parent- and child-reports and agreement between observations and child-reports for children aged 8-13 years old
3	Cross-sectional study	644	Ethnicity of the child	Socio-demographic characteristics, family and home-related factors	SSB intake among children aged 6-13 years old
4	Cross-sectional study	644	Ethnicity of the child	Socio-demographic characteristics, family and home-related factors	Snack intake among children aged 6-13 years old
5	Cross-sectional study	644	Ethnicity of the child	Parenting styles and feeding styles	Snack intake among children aged 6-13 years old
6	Systematic review	13 studies	n/a	n/a	Healthy behaviours among socially disadvantaged children aged 0-12 years old in Europe
7	Descriptive study	n/a	n/a	Social Marketing and Intervention Mapping	'Water Campaign' development description
8	Controlled trial	1009	n/a	Intervention versus control	SSB consumption of children aged 6-12 years old

References

1. Lien N, Henriksen HB, Nymoen LL, Wind M, Klepp KI. Availability of data assessing the prevalence and trends of overweight and obesity among European adolescents. *Public Health Nutr* 2010; **13**(10A)**:** 1680-7.

2. Morgen CS, Sorensen TI. Obesity: global trends in the prevalence of overweight and obesity. *Nat Rev Endocrinol* 2014; **10**(9)**:** 513-4.

3. Schonbeck Y, Talma H, van Dommelen P, Bakker B, Buitendijk SE, Hirasing RA *et al.* Increase in prevalence of overweight in Dutch children and adolescents: a comparison of nationwide growth studies in 1980, 1997 and 2009. *PLoS ONE* 2011; **6**(11)**:** e27608.

4. *Statistics Netherlands: Health Enquete 2013*. Statistics Netherlands (CBS): The Hague, The Netherlands, 2013.

5. Olds T, Maher C, Zumin S, Peneau S, Lioret S, Castetbon K *et al.* Evidence that the prevalence of childhood overweight is plateauing: data from nine countries. *Int J Pediatr Obes* 2011; **6**(5-6)**:** 342-60.

6. Hu FB. Resolved: there is sufficient scientific evidence that decreasing sugar-sweetened beverage consumption will reduce the prevalence of obesity and obesity-related diseases. *Obes Rev* 2013; **14**(8)**:** 606-19.

7. de Ruyter JC, Olthof MR, Seidell JC, Katan MB. A trial of sugar-free or sugar-sweetened beverages and body weight in children. *N Engl J Med* 2012; **367**(15)**:** 1397-406.

8. Ebbeling CB, Feldman HA, Chomitz VR, Antonelli TA, Gortmaker SL, Osganian SK *et al.* A randomized trial of sugar-sweetened beverages and adolescent body weight. *N Engl J Med* 2012; **367**(15)**:** 1407-16.

9. Schmidt Morgen C, Rokholm B, Sjoberg Brixval C, Schou Andersen C, Geisler Andersen L, Rasmussen M *et al.* Trends in prevalence of overweight and obesity in danish infants, children and adolescents--are we still on a plateau? *PLoS ONE* 2013; **8**(7)**:** e69860.

10. Rokholm B, Baker JL, Sorensen TI. The levelling off of the obesity epidemic since the year 1999--a review of evidence and perspectives. *Obes Rev* 2010; **11**(12)**:** 835-46.

11. Moss A, Klenk J, Simon K, Thaiss H, Reinehr T, Wabitsch M. Declining prevalence rates for overweight and obesity in German children starting school. *Eur J Pediatr* 2012; **171**(2)**:** 289-99.

12. Nichols MS, Silva-Sanigorski A, Cleary JE, Goldfeld SR, Colahan A, Swinburn BA. Decreasing trends in overweight and obesity among an Australian population of preschool children. *Int J Obes (Lond)* 2011; **35**(7)**:** 916-24.

13. Vinck J, Brohet C, Roillet M, Dramaix M, Borys JM, Beysens J *et al.* Downward trends in the prevalence of childhood overweight in two pilot towns taking part in the VIASANO community-based programme in Belgium: data from a national school health monitoring system. *Pediatr Obes* 2016; **11**(1)**:** 61-7.

14. Wabitsch M, Moss A, Kromeyer-Hauschild K. Unexpected plateauing of childhood obesity rates in developed countries. *BMC Med* 2014; **12**(1)**:** 17.

15. Romon M, Lommez A, Tafflet M, Basdevant A, Oppert JM, Bresson JL *et al.* Downward trends in the prevalence of childhood overweight in the setting of 12-year school- and community-based programmes. *Public Health Nutr* 2009; **12**(10)**:** 1735-42.

16. Roberto CA, Swinburn B, Hawkes C, Huang TT, Costa SA, Ashe M *et al.* Patchy progress on obesity prevention: emerging examples, entrenched barriers, and new thinking. *Lancet* 2015; **385**(9985)**:** 2400-9.

17. Flynn MA, McNeil DA, Maloff B, Mutasingwa D, Wu M, Ford C *et al.* Reducing obesity and related chronic disease risk in children and youth: a synthesis of evidence with 'best practice' recommendations. *Obes Rev* 2006; **7 Suppl 1:** 7-66.

18. Fagg J, Chadwick P, Cole TJ, Cummins S, Goldstein H, Lewis H *et al.* From trial to population: a study of a family-based community intervention for childhood overweight implemented at scale. *Int J Obes* 2014.

19. Braun KL, Nigg CR, Fialkowski MK, Butel J, Hollyer JR, Barber LR *et al.* Using the ANGELO Model To Develop the Children's Healthy Living Program Multilevel Intervention To Promote Obesity Preventing Behaviors for Young Children in the US-Affiliated Pacific Region. *Child Obes* 2014; **10**(6)**:** 474-81.

20. Van Koperen MT, Van der Kleij RM, Renders C, Crone M, Hendriks A-M, Jansen M *et al.* Design of CIAO, a research program to support the development of an integrated approach to prevent overweight and obesity in the Netherlands. *BMC Obesity* 2014; **1**(5).

21. Bleich SN, Segal J, Wu Y, Wilson R, Wang Y. Systematic review of community-based childhood obesity prevention studies. *Pediatrics* 2013; **132**(1)**:** e201-10.

22. Birch LL, Ventura AK. Preventing childhood obesity: what works? *Int J Obes (Lond)* 2009; **33 Suppl 1:** S74-81.

23. Kremers SP, de Bruijn GJ, Visscher TL, 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.

24. 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* 1999; **29**(6 Pt 1)**:** 563-70.

25. Government UK. *Change 4 Life - One Year On.* U.K. Government, 2010.

26. Evans WD, Necheles J, Longjohn M, Christoffel KK. The 5-4-3-2-1 go! Intervention: social marketing strategies for nutrition. *J Nutr Educ Behav* 2007; **39**(2 Suppl)**:** S55-9.

27. Huhman ME, Potter LD, Nolin MJ, Piesse A, Judkins DR, Banspach SW *et al.* The Influence of the VERB campaign on children's physical activity in 2002 to 2006. *Am J Public Health* 2010; **100**(4)**:** 638-45.

28. Mathews LB, Moodie MM, Simmons AM, Swinburn BA. The process evaluation of It's Your Move!, an Australian adolescent community-based obesity prevention project. *BMC Public Health* 2010; **10:** 448.

29. te Velde SJ, van Nassau F, Uijtdewilligen L, van Stralen MM, Cardon G, De Craemer M *et al.* Energy balance-related behaviours associated with overweight and obesity in preschool children: a systematic review of prospective studies. *Obes Rev* 2012; **13 Suppl 1:** 56-74.

30. Borys JM, Le Bodo Y, Jebb SA, Seidell JC, Summerbell C, Richard D *et al.* EPODE approach for childhood obesity prevention: methods, progress and international development. *Obes Rev* 2012; **13**(4)**:** 299-315.

31. Van Koperen TM, Jebb SA, Summerbell CD, Visscher TL, Romon M, Borys JM *et al.* Characterizing the EPODE logic model: unravelling the past and informing the future. *Obes Rev* 2013; **14**(2)**:** 162-70.

32. Gewicht) YoHWJOG. "Youth on Healthy Weight" (Jongeren Op Gezond Gewicht). In.

33. Romon M, Duhamel A, Salleron J, Lommez A, Meyer J, Borys JM. Évolution de la prévalence du surpoids et de l'obésité chez les enfants de 4 à 11 ans entre 2005 et 2010 dans les villes <EPODE>. *Nutrition Clinique et Métabolisme* 2010; **24**(S1).

34. Andreasen AR. Social Marketing: Its definition and domain. *Journal of Public Policy & Marketing* 1994; **13**(1)**:** 7.

35. French J, Blair-Stevens C, McVey D, Merritt R. *Social Marketing and Public Health – Theory and Practice*, Oxford University Press: Oxford, 2010.

36. Government UK. Change 4 Life - One Year On. In: U.K. Government, 2010.

37. Evans WD, Christoffel KK, Necheles JW, Becker AB. Social marketing as a childhood obesity prevention strategy. *Obesity (Silver Spring)* 2010; **18 Suppl 1:** S23-6.

38. Stead M, Hastings G, McDermott L. The meaning, effectiveness and future of social marketing. *Obes Rev* 2007; **8 Suppl 1:** 189-93.

39. Gracia-Marco L, Vicente-Rodriguez G, Borys JM, Le Bodo Y, Pettigrew S, Moreno LA. Contribution of social marketing strategies to community-based obesity prevention programmes in children. *Int J Obes (Lond)* 2011; **35**(4)**:** 472-9.

40. Rayner M. Social marketing: how might this contribute to tackling obesity? *Obes Rev* 2007; **8 Suppl 1:** 195-9.

41. Griffiths J, Blair-Stevens C, Thorpe A. Social Marketing for health and specialised health promotion. In: *World Social Marketing*. Brighton & Hove City, England: National Social Marketing Centre, 2008.

42. Evans WD. How social marketing works in health care. *BMJ* 2006; **332**(7551)**:** 1207-10.

43. Government US. CDCynergy, Social Marketing Edition - an interactive training and decision-support tool. In: U.S. Department of Health and Human Services CfDC, (ed): Centers for Disease Control, U.S. Government, 2014.

44. King L, Gill T, Allender S, Swinburn B. Best practice principles for community-based obesity prevention: development, content and application. *Obes Rev* 2011; **12**(5)**:** 329-38.

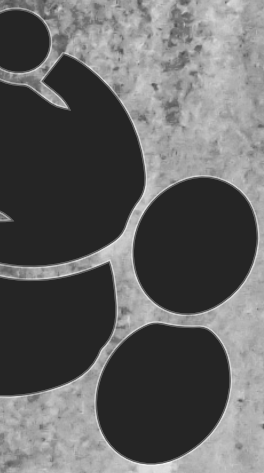
45. van de Gaar VM, Jansen W, van Grieken A, Borsboom G, Kremers S, Raat H. Effects of an intervention aimed at reducing the intake of sugar-sweetened beverages in primary school children: a controlled trial. *Int J Behav Nutr Phys Act* 2014; **11:** 98.

46. Blanchette LMG, van de Gaar VM, Raat H, French J, Jansen W. The development of the "Water Campaign": Combining social marketing and intervention mapping. *Journal of Social Marketing* 2016; **6**(4)**:** 16.

47. Jansen W, Borsboom G, Meima A, Zwanenburg EJ, Mackenbach JP, Raat H *et al.* Effectiveness of a primary school-based intervention to reduce overweight. *Int J Pediatr Obes* 2011; **6**(2-2)**:** e70-7.

48. Bartholomew LK, Parcel GS, Kok G, Gottlieb NH, Fernandez ME. *Planning health promotion programs, an intervention mapping approach*, 3rd edn Jossey-Bass: Francisco, California, 2011.

49. Krul C, Blanchette LMG, Jansen W, Meima B. City of Rotterdam: Scoping Enojy Being Fit Family Approach [Scoping Rapport: Gezinsaanpak Lekker Fit!]. In. Rotterdam, the Netherlands: City of Rotterdam, Department of Sports and Culture, 2012.



Part I:

Assessing nutritional behaviour of children

2

Do children report differently from their parents and from observed data? Cross-sectional data on fruit, water, sugar-sweetened beverages and break-time foods

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Abstract

Background: Reliable assessment of children's dietary behaviour is needed for research purposes. The aim of this study was (1) to investigate the level of agreement between observed and child-reported break-time food items; and (2) to investigate the level of agreement between children's reports and those of their parents regarding children's overall consumption of fruit, water and sugar-sweetened beverages (SSB).

Methods: The children in this study were 9 to 13 years old, attending primary schools in Rotterdam, the Netherlands. Children were observed with respect to foods brought for break-time at school. At the same day, children completed a questionnaire in which they were asked to recall the food(s) they brought to school to consume during break-time. Only paired data (observed and child-reported) were included in the analyses (n=407 pairs). To determine each child's daily consumption and average amounts of fruit, water and SSB consumed, children and their parents completed parallel questionnaires. Only paired data (parent-reported and child-reported) were included in the analyses (n=275 pairs). The main statistical measures were level of agreement between break-time foods, fruit, water and SSB; and Intra-class Correlation Coefficients (ICC).

Results: More children reported bringing sandwiches and snacks for break-time than was observed (73% vs 51% observed and 84% vs 33% observed). The overall agreement between observed and child-reported break-time foods was poor to fair, with ICC range 0.16-0.39 ($p<0.05$). Children reported higher average amounts of SSB consumed than did their parents (1.3 vs 0.9 litres SSB, $p<0.001$). Child and parent estimations of the child's water and fruit consumption were similar. ICC between parent and child reports was poor to good (range 0.22-0.62, $p<0.05$).

Conclusions: Children report higher on amount of break-time foods as compared to observations and children's reports of SSB consumption are higher than those of their parents. Since the level of agreement between the observed break-time foods and that reported by children and the agreement of child's intake between parent and child reports are relatively weak, future studies should focus on improving methods of evaluating children's consumption behaviour or on ways on how to best use and interpret multiple-source dietary intake data.

Background

Insight into children's consumption habits is important for two main reasons. Firstly, it is widely known that eating and drinking habits can contribute to the development of childhood overweight [1]. Secondly, the consumption habits that we have as children continue into adulthood, when the risk of overweight remains [2]. Therefore, gaining insight into a child's consumption habit is important. However, for assessing dietary behaviour on the level of pre-specified foods and food groups there seems to be no perfect measurement method [3].

Interventions aimed at changing children's consumption behaviour are commonly evaluated using information on the habitual consumption behaviour of the child reported by parents [4, 5]. Unfortunately, research has shown that parents may not always be a reliable source of information on the child's habitual intake of foods and drinks [6, 7]. In addition, social desirability, especially among parents, may lead to over-reporting of the intake of healthy food items and under-reporting of the intake of unhealthy food items [3].

The cognitive ability of children to self-report their intake of foods and food groups is also doubtful [8, 9]. The ability to self-report improves when a child grows older [5], with some suggesting that children should at least be ≥12 years old to report more reliably on their dietary intake [10]. Other research has shown that children from the age of 8 years old may already be reliable sources of information regarding their own food intake over the past 24 hours [5, 8, 11, 12]. However, due to their unfamiliarity with concepts such as 'frequency' and 'averaging', it is debatable whether children of this age respond accurately to food frequency questionnaires when items cover longer periods [5, 8, 11]. Indeed, when Börnhorst and colleagues investigated the nature and magnitude of selective misreporting of food intake of different food items, they found children's level of under-reporting to be 8.0%, with over-reporting at 3.4% [3]. Other studies have shown under-reporting of intake to be significantly higher in obese children [8, 11, 13]. These same studies have also demonstrated that not only does the extent of misreporting increase with age, in contrast to previous mentioned studies [5, 10]. Also, those who under-report on one occasion are likely to under-report on a second occasion, in which case reporter bias cannot be eliminated by repeated measures. Then again, research by Burrows and colleagues suggests that children

between the ages 8 to 11 years old may report reliably as compared to either their father or their mother with regard to the child's dietary intake of specific foods [14].

As can be concluded from the arguments above, all of the available methods for measuring dietary behaviour on the level of pre-specified foods and food groups may have some degree of misreporting and error [8, 11, 15-17], which makes measuring a child's habitual consumption a challenging aspect of behaviour research. As previous research has indicated, in order for us to choose the most accurate measurement method for assessing children's eating behaviour, we must improve our understanding of discrepancies between observed and reported behaviour [18-20].

The aim of this study was twofold: (1) to investigate the level of agreement between observed and child-reported break-time food items; and (2) to investigate the level of agreement between children's reports and those of their parents regarding the children's overall consumption of fruit, water and sugar-sweetened beverages (SSB).

Methods

Our cross-sectional study used data from the population-based 'Water Campaign' intervention [21]. This controlled trial aims to assess the effects of a combined school- and community-based intervention on children's SSB consumption. The Medical and Ethical Review Committee of the Erasmus Medical Centre issued a 'declaration of no objection' (i.e., formal waver) for this study (reference number MEC-2011-183). Four primary schools located in multi-ethnic, disadvantaged neighbourhoods in Rotterdam, the Netherlands, were included in the study. This resulted in a total of 1288 children aged 6 to 13 years old (grades 3 to 8) who were invited to participate. Passive parental consent was obtained. Parents (and children) received an information brochure to notify and inform them about the intervention and study participation. The study was also announced by the school, via the school letter and through the teachers and by flyers which were visible throughout the school. Parents (and children) were free to refuse participation without giving any explanation. They could do so by informing one of the teachers at their school or one of the researchers when present at school. At all times, the researchers could be contacted by a special phone-number or e-mail, for instance to decline participation [21].

The questionnaire items were based on previously widely used questionnaires, mainly used in earlier Dutch studies [22, 23]. We used two questionnaires to assess habitual consumption: one version was completed by children in grades 6 to 8 and another was completed by the parents of children in grades 3 to 8. Children filled in their questionnaire at school in the presence of a researcher and their teacher. The parent questionnaire was to be completed at home by the main caregiver of the child, within a period of maximum two months.

To objectively record what children brought to school to consume during break-time we used observation forms. These forms have been frequently applied for these kinds of information gathering by the Youth Health Care in recent years. Observations (unobtrusive) at school for children in grades 3 to 8 were conducted by trained personnel.

For the present study, we used baseline data from children in grades 6 to 8 only (aged 9 to 13 years old). Pairing of data from the child questionnaires with data from the parent questionnaires or with data from the observations generated a study population of 539 children.

Population characteristics

Socio-demographic characteristics were obtained from parent and/or child reports: the parent and child questionnaires included items on child's gender, age, grade and ethnic background. Ethnic background was determined by country of birth of the parents according to definitions given by Statistics Netherlands [24]. The child's ethnic background was defined as Dutch only if both parents had been born in the Netherlands; if one of the parents had been born in another country, ethnic background was defined according to that country; and if both parents had been born in different foreign countries, ethnic background was defined as the mother's country of birth. Ethnic background was categorised as either Dutch, Surinamese/Antillean, Moroccan/Turkish, or other/unknown.

Gender, age and educational level of the caregiver were recorded. The caregiver's highest educational level was categorised as either 'high'; 'mid-high'; 'mid-low'; or 'low', based on standard Dutch cut-off points [25].

Trained personnel measured the child's height and weight at baseline. Weight status was determined by calculating the Body Mass Index (BMI) in kg/m^2 with height measured to the nearest 0.1cm and weight measured to the nearest 0.2kg, in light clothing or gym clothes, according to a national standardized protocol for Youth Health Care [26]. Children were categorised as being either 'non-overweight' or 'overweight or obese', based on BMI cut-off points published by the International Obesity Task Force [27].

Data pairs from observations and child reports

Trained public health professionals observed and registered which food items children brought along for the 10:00 am break at school. During the same morning, children completed a questionnaire in which they were asked to recall the food(s) they brought to school to consume during break-time. In Supplement 1 and 2, the observation form and the child's questionnaire item are shown. Data from the observations and child reports were grouped into three categories ('sandwiches', 'fruit', and 'snacks') by two researchers independently of each other. Any inconsistencies were discussed and where necessary a third researcher was included in order to reach agreement. If food items did not fit into one of the categories, these items were coded as 'missing' (<5%). A 'nothing' category was added for those children who had brought nothing to eat during break-time. The four categories were dichotomised into (0) 'not brought along', and (1) 'yes, brought along'. Paired data (observed and child-reported) were included in the analyses (n=407 pairs).

Data pairs from parent and child reports

Children and their parents completed parallel questionnaires regarding the child's fruit, water and SSB intake. We assessed 'daily consumption' and 'average amounts consumed'. Data collection took place over a period of two months, in April and May. Paired data (parent-reported and child-reported) were included in the analyses (n=275 pairs).

Daily consumption of fruit was measured using the question "Does your child/do you consume fruit on a daily basis?", with answer categories 'no, not every day' or 'yes, every day'. Average amounts of fruit consumed was measured using the question 'On a day your child eats/you eat fruit, how many pieces of fruit does your child/do you consume on

average?'. Answer possibilities ranged from 'half a piece of fruit' to 'two or more pieces of fruit'. Examples were given to assist respondents in determining the number of fruit pieces (e.g., tangerine as a half piece; an apple as one piece).

Daily consumption of water was assessed using the questions 'Does your child/do you drink water on a daily basis?', with answer categories 'no, not every day' or 'yes, every day'. Average amounts of water consumed was measured using the question 'On a day your child drinks/you drink water, how many glasses of water does your child/do you consume on average?'. Answer possibilities ranged from 'none' to 'five or more glasses of water'. The total water intake per day, converted to litres (for comparison with SSB), was calculated by multiplying the number of glasses by an estimated average volume of 200ml.

Daily consumption of SSB was measured using the question 'Does your child/ do you drink SSB on a daily basis?', with answer categories 'no, not every day' or 'yes, every day'. Average amounts of SSB consumed was measured using the question 'On a day your child drinks/you drink SSB, how many glasses (250ml), cans (330ml) or bottles (500ml) does your child/do you consume on average a day?'. Answer categories ranged from 'none' to '5 or more'. The total SSB intake per day, converted to litres, was calculated by adding up the volumes of the total number of glasses, cans and bottles that were consumed. Examples of SSB were provided, based on our definition of SSB: *Beverages containing added sugar, sweetened dairy products (e.g., chocolate milk), fruit juice (e.g., apple juice), soft drinks (e.g., cola) and energy drinks (e.g., sport energy drinks).* In Supplement 3, an overview of the questionnaire items used to assess SSB intake are given.

Analysis

For the dichotomous variables in the observed-child data pairs and parent-child data pairs, we calculated overall level of agreement (% same quartile). Kappa was used as an effect-size measure for the level of agreement, ranging from '0' (agreement as expected by chance) to '1' (perfect agreement) [28]. Agreement strength was based on the following criteria: 0.00 to 0.20 = 'poor'; 0.21 to 0.40 = 'fair'; 0.41 to 0.60 = 'moderate'; 0.61 to 0.80 = 'good'; 0.81 to 1.00 = 'very good' [29].

To explore the relationship between the different measurements methods with regard to consumption, Intra-class Correlation Coefficients (ICC) were calculated for each of the analysed behaviours. This generated a measure of absolute agreement for the dichotomous variables. For the continuous variables in the parent-child data pairs, the calculated ICC was a measure of consistency. The ICC is a value that ranges between 0 and 1, with a higher ICC corresponding to a better correlation. The following ICC cut-points were used: 0.00 to 0.20 = 'poor'; 0.21 to 0.40 = 'fair'; 0.41 to 0.60 = 'moderate'; 0.61 to 0.80 = 'good'; 0.81 to 1.00 = 'very good' [30, 31]. The mean (SD) of the difference and the limits of agreement were also calculated using Paired T-tests and used for input for the Bland Altman plots [32].

The McNemar test was used to compare the child's reports with that of the observed reports or the reports by parents (level of significance set at 5%) [32].

Results

Table 1 provides information about several population characteristics. In the observed-child data pairs (n=407), the children's mean age was 10.6 years (SD 1.1), 49.5% were girls, 22.9% were of Dutch origin, and 22.6% were overweight or obese.

In the parent-child data pairs (n=275), the children's mean age was 11.1 years (SD 1.0), 54.5% were girls, 20.2% were of Dutch origin, and 26.0% were overweight or obese. With regard to the caregivers, 88.8% were female, their mean age was 38.4 years (SD 9.1), and 27.1% were classified as having a low level of education.

Table 1: Characteristics of children and caregivers included in study

	Observed-child data pairs n = 407		Parent-child data pairs n = 275	
	n	Mean (SD) or %	n	Mean (SD) or %
Child characteristics				
Gender, % girls	200	49.5%	150	54.5%
missing	*3*	*0.7%*	*0*	*0.0%*
Age	406	10.64 (1.1)	274	11.06 (1.0)
missing	*1*	*0.2%*	*1*	*0.4%*
Grade				
- Grade 6	161	39.6%	97	35.3%
- Grade 7	78	19.2%	101	36.7%
- Grade 8	168	41.2%	77	28.0%
missing	*0*	*0.0%*	*0*	*0.0%*
Ethnicity				
- Dutch	93	22.9%	56	20.4%
- Surinamese/Antillean	97	23.8%	56	20.4%
- Moroccan/Turkish	118	29.0%	90	32.7%
- Other/unknown	99	24.3%	73	26.5%
Weight status, % overweight/obese	89	22.6%	68	25.9%
missing	*13*	*3.2%*	*12*	*4.4%*
Caregiver characteristics				
Age	-	-	273	38.42 (9.1)
missing			*2*	*0.7%*
Gender, % female	-	-	223	88.8%
missing			*24*	*8.7%*
Level of Education	-	-		
- High			45	16.7%
- Mid-high			77	28.6%
- Mid-low			74	27.5%
- Low			73	27.1%
missing			*6*	*2.2%*

Observed-child data pairs

Table 2 shows the results of the analyses of the observed and child reports. Relative to observed reports of brought foods, the children themselves reported a higher amount of sandwiches (73.0% vs 50.6% observed) and snacks (83.8% vs 33.2% observed).

The level of agreement was poor (total κ range 0.11 to 0.24, p<0.05). The ICC between the observed and child-reported brought break-time foods was poor to fair (total ICC range 0.16 to 0.39, p<0.05).

Table 2: Agreement between observed and child reports on food items that children brought to school with the intention to consume during break-time at school

Primary outcomes - categories	n	Number of times observed (%)[5]	Number of times reported by child (%)[5]	Overall agreement	Kappa[1,2]	*P*-value[3]	ICC[1,4]
'Nothing' (brought nothing with them)	407	16 (3.9%)	7 (1.7%)	95.8%	.24 ***	0.049	.39 ***
Sandwiches	407	206 (50.6%)	297 (73.0%)	54.6%	.09	< 0.001	.16 *
Fruit & vegetables	407	76 (18.7%)	39 (9.6%)	78.1%	.11 *	< 0.001	.21 **
Snacks	407	135 (33.2%)	341 (83.8%)	38.1%	.01	< 0.001	.02

[1] Significance (2-tailed): * 0.05 level, ** 0.01 level, *** ≤0.001 level
[2] Cohen's Kappa - corrected for agreement based on chance
[3] McNemar test
[4] Average Intra-class Correlation Coefficients (ICC) resembles measure of absolute agreement
[5] In case multiple food items were brought for break-time, the sum of the category percentages may exceed 100%

Parent-child data pairs

Table 3 shows the mean and (SD) of average amounts of fruit, water and SSB consumed and the proportion who consume these items daily as reported by parents and children. In Supplement 4, the Bland Altman plots are given.

Average amounts of fruit consumed reported by parents and children was similar in both groups and children reported a slightly lower daily consumption of fruit compared to their

parents report. The level of agreement was poor (κ daily fruit = 0.12, p=0.047), with overall agreement between children and parents of 56.8%.

The average amounts of water consumed in litres reported by parents and children was similar. Children reported consuming water on a daily basis significantly more often as compared to their parents report. The level of agreement was moderate (κ daily water = 0.44, p<0.001).

The average amounts of SSB consumed in litres reported by children was significantly higher than the volume reported by their parents. Children indicated consuming SSB on a daily basis also significantly less frequent than did their parents. Level of agreement was poor (κ daily SSB = 0.19, p=0.001).

The ICCs between the child and parent reports were poor to good (total ICC range 0.22 to 0.62). For fruit consumption, the ICC ranged from 0.22 to 0.39 (fair ICC, p<0.05) and for SSB consumption from 0.32 to 0.44 (fair to moderate ICC, p<0.001); the ICC for water consumption was the highest, with a range of 0.59 to 0.62 (moderate to good ICC, p<0.001).

The results are reported in accordance with STROBE (Strengthening the Reporting of Observational Studies in Epidemiology). See Supplement 5 for the STROBE checklist [33].

Table 3: Agreement between parent and child reports on consumption of fruit, water and sugar-sweetened beverages (SSB)

Primary outcomes	n	Parent reported Mean (SD) or n (%)	Child reported Mean (SD) or n (%)	Difference Mean (SD)[3]	Overall agreement	Kappa[1,2]	*P*-value[3]	ICC[1,4]
Average amount of fruit consumed (# pieces)	252	1.42 (0.5)	1.48 (0.5)	0.06 (0.6)	-	-	0.150	.39 ***
Daily fruit, % yes	250	117 (46.8%)	99 (39.6%)	-	56.8%	.12 *	0.101	.22 *
Average amount of water consumed (L)	253	0.63 (0.3)	0.66 (0.3)	0.04 (0.3)	-	-	0.065	.59 ***
Daily water, % yes	258	174 (67.4%)	194 (75.2%)	-	76.7%	.44 ***	0.013	.61 ***
Average amount of SSB consumed (L)	253	0.92 (0.6)	1.33 (0.8)	0.41 (0.9) ***	-	-	< 0.001	.44 ***
Daily SSB, % yes	258	141 (54.7%)	83 (32.2%)	-	58.1%	.19 **	< 0.001	.32 ***

[1] Significance (2-tailed): * 0.05 level, ** 0.01 level, *** ≤0.001 level
[2] Cohen's Kappa - corrected for agreement based on chance
[3] McNemar test (dichotomous variables) or Paired T-test (continues variables)
[4] Average Intra-class Correlation Coefficients (ICC) resembles measure of absolute agreement (dichotomous variables) or consistency (continues variables)

Discussion

The level of agreement between the observed break-time foods and the children's self-report was poor to fair: children reported higher quantities on their break-time foods of sandwiches and snacks. There was a poor level of agreement between the reports from parents and children regarding whether children consumed fruit and SSB daily, and a moderate level of agreement for daily water consumption. Despite these differences, on a group level children and parents did report similar average amounts regarding what the child consumes on a day and whether or not he/she drinks water or eats fruit, with the

highest ICC for water (good agreement). The reports on average amounts of SSB consumed differed substantially between children and parents however.

Our result of 67% overall agreement between observed and child-reported break-time foods is similar to that seen in previous studies. For example, in a study by Weber et al., children were able to correctly recall 75% of the school meal foods that observers had documented that they had on their plate [34]. Subsequently, Baranowski and colleagues found 83% agreement between observed and recalled 12-hour food consumption among children [35]. Despite this agreement, we also found differences, for example between observed and child-reported sandwich intake. The higher reported amounts by children could be explained by the fact that while observers only counted the sandwiches that children brought to school to eat during break-time at 10:00 am, some children may well have reported the number of sandwiches brought to consume during both break-time and lunch. Apart from this, our overall findings indicate that children also report higher amounts of their break-time snacks. A further possible explanation for this lack of agreement is that children find it difficult to estimate the amount of foods and food items, as other studies have reported [8, 9, 11].

Whereas on a group level the reports from parents and children regarding average amounts of fruit and water consumed were similar, those regarding average amounts of SSB consumed were dissimilar. These discrepancies could be due to children being more aware of when and how much fruit and water they consume than how much SSB they consume [8, 9, 11]. Fruit and water may be more straightforward than SSB. Although the definition of SSB was explained to the children and examples of SSB were provided, the children may still not have completely understood what SSB is. After all, it is more difficult to recall your consumption behaviour if you do not fully understand what it is you were supposed to remember, for example when remembering which drinks to include when answering certain questions. As a further explanation for such misreporting, one could consider the argument that healthier food or drink types such as fruit and water are more likely to be over-reported than unhealthy food or drink types such as SSB. This has been addressed by Börnhorst and colleagues in the context of intentional selective misreporting by parents (of 6101 children aged 2-9; mean age 6.1, SD 1.8): this study found that foods perceived as unhealthy (such as sugary products) were more likely to be under-reported whereas foods perceived to be more healthy (such as fruit and vegetables) were

less likely to be under-reported [3]. So it would seem that there is a tendency towards over-reporting of healthier habits and towards socially desirable answers by parents [36, 37]. This might explain why, in the current study, average amounts of SSB consumed was dissimilar between parent and child reports while average amounts of fruit and water consumed was not. Yet another possible explanation for the discrepancy between child and parent report could be that children could have bought or swapped food items, without their parents knowing. In particular, this could especially be the case for items such as SSB's. However, the potential over-reporting of healthy foods by parents could mean in our case that water and fruit intake reports of parents are higher than the true intake. Yet, children and parents reports on the child's intake of fruit and water were similar. The role of social desirability on the answers of parents or children therefore stays obscure. Therefore, further research is required to address whether there are indeed differences between parents' and children's reports of healthy and unhealthy consumption in children.

The time between the child and parent reports ranged from one day to two months. Theoretically it is possible that seasonal influences on eating patterns or changes in feeding behaviours could have contributed to the discrepancies between self-reports of parents and children. Because our questions were on daily consumption and average amounts consumed, we assume that if this time delay between reports of parents and children was of influence, it will be of small influence since habit strength in consumption and feeding patterns tends to be high [38].

Others have looked for explanations for the discrepancies seen between parents and children. For example, McPherson et al. [8] suggest that one of the reasons that parents and children report different intakes is that they have different perceptions of the child's food and drink intake. Additionally or alternatively, the discrepancy between parents and children could be explained by reporting bias, with parents reporting socially desirable answers more frequently than children [3].

A possible explanation for the higher reports of snacks as break-time food item (and possible over-reporting of SSB) by children could be due to personal preferences or personal characteristics, for example. Since snacks (and SSB) are more likely to be children's favourite food (or drink) types, this could have been reflected in their reporting behaviour. In addition, we found statistically significant differences between the

children's reports of overweight-related foods and beverages and that observed or reported by parents, however hereby we contradict the findings found by Bennett et al. [36].

Previous research among parents and children reporting on child's consumption behaviour has found that parental reports are slightly more accurate than children's reports: 78% compared with 72% agreement regarding different food items and food types (children under study between the ages of 6 to 11 years old) [15]. Given the differences and low levels of agreement that we found, we would recommend combined measurement methods when assessing child's habitual dietary behaviour on the level of pre-specified foods or food groups. This is also suggested by Eck and colleagues who concluded in their study that the children's contribution could be of value, given that the combined parent-and-child report was more accurate that the individual parent report (children under study between the ages of 4 to 10 years old) [7]. Reports from multiple sources are therefore recommended over single-source reports, especially for children younger than the age of 8 years old as proposed by Burrows [4]. As seen in other public health fields, the question then remains on how to process data from multiple sources [39].

Strengths and limitations

One of the strengths of this study is that it provides a unique assessment of different types of behaviour consumption in an ethnically diverse population. A further strength is the combined use of three measures – observations, parent questionnaires and child questionnaires – which provides insight into the added value of the various different assessment methods.

However, there are also limitations which should be acknowledged. Firstly, a maximum period of up to two months could have elapsed between completion of the child questionnaire and the parent questionnaire. Although our questions considered daily consumption and average amounts consumed, the time delay between parent and child reports has to be acknowledged when interpreting the results. Also, the data collection took place in the months April and May. As mentioned before, a seasonal effect cannot be ruled out, but given the timing of the measurements, we assume this is unlikely. Secondly, the questionnaire was provided in Dutch only, which could have been a barrier

for some parents given the diverse ethnicity of our study population. Although we provided parents and children with definitions and examples, there may have been some confusion as to what constitutes the different snack and SSB categories. For instance, some members of the general population may not be aware of the differences between fruit juices such as apple juice and sweetened dairy products or energy drinks. Also, mis-categorisation by observers and children could have occurred when reporting on the brought food items. Lastly, regarding the parent-child comparison, we do not have an objective measurement of the reported intake and therefore cannot say anything about the 'true' intake, which is a limitation of the utility of that data.

Conclusions

Children not only report higher than observed on amount of break-time foods of sandwiches and snacks, they also report a higher SSB intake than that reported by their parents. However, children and parents have similar estimations of the child's water and fruit consumption. Since the level of agreement between the observed break-time foods and that reported by children and the agreement of child's intake between parent and child reports are relatively weak, future studies should focus on improving methods of evaluating children's consumption behaviour or on ways on how to best use and interpret multiple-source dietary intake data.

References

1. Swinburn BA, Caterson I, Seidell JC, James WP. Diet, nutrition and the prevention of excess weight gain and obesity. *Public Health Nutr* 2004; **7**(1A)**:** 123-46.
2. Mikkila V, Rasanen L, Raitakari OT, Pietinen P, Viikari J. Consistent dietary patterns identified from childhood to adulthood: the cardiovascular risk in Young Finns Study. *Br J Nutr* 2005; **93**(6)**:** 923-31.
3. Bornhorst C, Huybrechts I, Ahrens W, Eiben G, Michels N, Pala V *et al.* Prevalence and determinants of misreporting among European children in proxy-reported 24 h dietary recalls. *Br J Nutr* 2013; **109**(7)**:** 1257-65.
4. Burrows TL, Martin RJ, Collins CE. A systematic review of the validity of dietary assessment methods in children when compared with the method of doubly labeled water. *J Am Diet Assoc* 2010; **110**(10)**:** 1501-10.
5. Livingstone MB, Robson PJ, Wallace JM. Issues in dietary intake assessment of children and adolescents. *Br J Nutr* 2004; **92 Suppl 2:** S213-22.
6. Baranowski T, Sprague D, Baranowski JH, Harrison JA. Accuracy of maternal dietary recall for preschool children. *J Am Diet Assoc* 1991; **91**(6)**:** 669-74.
7. Eck LH, Klesges RC, Hanson CL. Recall of a child's intake from one meal: are parents accurate? *J Am Diet Assoc* 1989; **89**(6)**:** 784-9.
8. McPherson RS, Hoelscher DM, Alexander M, Scanlon KS, Serdula MK. Dietary assessment methods among school-aged children: Validity and reliability. *Prev Med* 2000; **31**(2)**:** S11-S33.
9. Smith AF, Baxter SD, Hardin JW, Guinn CH, Royer JA. Relation of Children's Dietary reporting accuracy to cognitive ability. *Am J Epidemiol* 2011; **173**(1)**:** 103-9.
10. Field AE, Peterson KE, Gortmaker SL, Cheung L, Rockett H, Fox MK *et al.* Reproducibility and validity of a food frequency questionnaire among fourth to seventh grade inner-city school children: implications of age and day-to-day variation in dietary intake. *Public Health Nutr* 1999; **2**(3)**:** 293-300.
11. Livingstone MB, Robson PJ. Measurement of dietary intake in children. *Proc Nutr Soc* 2000; **59**(2)**:** 279-93.
12. Hunsberger M, Pena P, Lissner L, Grafstrom L, Vanaelst B, Bornhorst C *et al.* Validity of self-reported lunch recalls in Swedish school children aged 6-8 years. *Nutr J* 2013; **12**(1)**:** 129.
13. Waling MU, Larsson CL. Energy intake of Swedish overweight and obese children is underestimated using a diet history interview. *J Nutr* 2009; **139**(3)**:** 522-7.
14. Burrows TL, Truby H, Morgan PJ, Callister R, Davies PS, Collins CE. A comparison and validation of child versus parent reporting of children's energy intake using food frequency questionnaires versus food records: who's an accurate reporter? *Clin Nutr* 2013; **32**(4)**:** 613-8.
15. Mack KA BJ, Presser S. Measuring and Improving Data Quality in Children's Reports of Dietary Intake. In: Breckenridge R, (ed) *Conference on Health Survey Research Methods*. Colorado, 1995.

16. Cade JE, Burley VJ, Warm DL, Thompson RL, Margetts BM. Food-frequency questionnaires: a review of their design, validation and utilisation. *Nutr Res Rev* 2004; **17**(1)**:** 5-22.

17. Dwyer JT, Krall EA, Coleman KA. The problem of memory in nutritional epidemiology research. *J Am Diet Assoc* 1987; **87**(11)**:** 1509-12.

18. Pinard CA, Davy BM, Estabrooks PA. Beverage intake in low-income parent-child dyads. *Eat Behav* 2011; **12**(4)**:** 313-6.

19. 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.

20. Tak NI, te Velde SJ, de Vries JH, 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**(4)**:** 275-85.

21. van de Gaar VM, Jansen W, van Grieken A, Borsboom G, Kremers S, Raat H. Effects of an intervention aimed at reducing the intake of sugar-sweetened beverages in primary school children: a controlled trial. *Int J Behav Nutr Phys Act* 2014; **11:** 98.

22. 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.

23. Veldhuis L, Struijk MK, Kroeze W, Oenema A, Renders CM, Bulk-Bunschoten AM *et al.* 'Be active, eat right', evaluation of an overweight prevention protocol among 5-year-old children: design of a cluster randomised controlled trial. *BMC Public Health* 2009; **9:** 177.

24. Swertz O, Duimelaar P, Thijssen J. *Statistics Netherlands. Migrants in the Netherlands 2004.* Statistics Netherlands: Voorburg/Heerlen, the Netherlands, 2004.

25. *Dutch Standard Classification of Education 2003*. Statistics Netherlands: Voorburg/Heerlen, Netherlands, 2004.

26. Bulk-Bunschoten AMW, Renders CM, Leerdam FJM, Hirasing RA. *Protocol for detection of overweight in preventive youth health care. [Signaleringsprotocol overgewicht in de jeugdgezondheidszorg]*. VUMC: Amsterdam, 2004.

27. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000; **320**(7244)**:** 1240-3.

28. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* 1986; **1**(8476)**:** 307-10.

29. Altman DG. *Practical statistics for medical research*, Chapman and Hall: London, 1990.

30. de Vet HC, Terwee CB, Knol DL, Bouter LM. When to use agreement versus reliability measures. *J Clin Epidemiol* 2006; **59**(10)**:** 1033-9.

31. Costa-Santos C, Bernardes J, Ayres-de-Campos D, Costa A, Amorim-Costa C. The limits of agreement and the intraclass correlation coefficient may be inconsistent in the interpretation of agreement. *J Clin Epidemiol* 2011; **64**(3)**:** 264-9.

32. Field A. *Discovering Statistics Using SPSS*, vol. Second Edition. SAGE Publications: London, 2005.

33. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP *et al.* The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* 2007; **370**(9596)**:** 1453-7.

34. Weber JL, Lytle L, Gittelsohn J, Cunningham-Sabo L, Heller K, Anliker JA *et al.* Validity of self-reported dietary intake at school meals by American Indian children: the Pathways Study. *J Am Diet Assoc* 2004; **104**(5)**:** 746-52.

35. Baranowski T, Dworkin R, Henske JC, Clearman DR, Dunn JK, Nader PR *et al.* The accuracy of children's self-reports of diet: Family Health Project. *J Am Diet Assoc* 1986; **86**(10)**:** 1381-5.

36. Bennett CA, de Silva-Sanigorski AM, Nichols M, Bell AC, Swinburn BA. Assessing the intake of obesity-related foods and beverages in young children: comparison of a simple population survey with 24 hr-recall. *Int J Behav Nutr Phys Act* 2009; **6:** 71.

37. Martins CC, Oliveira MJ, Pordeus IA, Paiva SM. Comparison between observed children's tooth brushing habits and those reported by mothers. *BMC Oral Health* 2011; **11:** 22.

38. McGowan L, Cooke LJ, Gardner B, Beeken RJ, Croker H, Wardle J. Healthy feeding habits: efficacy results from a cluster-randomized, controlled exploratory trial of a novel, habit-based intervention with parents. *Am J Clin Nutr* 2013; **98**(3)**:** 769-77.

39. Kraemer HC, Measelle JR, Ablow JC, Essex MJ, Boyce WT, Kupfer DJ. A new approach to integrating data from multiple informants in psychiatric assessment and research: mixing and matching contexts and perspectives. *Am J Psychiatry* 2003; **160**(9)**:** 1566-77.

Supplements

Supplement 1. Observation form

School:	Grade:	Date:					Observer:				
	Student	1	2	3	4	5	6	7	Etc.	…	…
Food items											
Nothing											
Fruit											
Vegetables											
Sandwiches											
Croissant, chocolate roll											
Rolls, bun, meusli bread											
Gingerbread, cracker											
Liga, Sultana											
Biscuits, cake											
Pie, muffin, pastry											
Candy, candy/chocolate-bars											
Chips, cheese, nuts											
Other, namely…											

Supplement 2. Questionnaire item child

Break-time Foods

What kind of foods did you brought to school to day to consume during break-time?
(You may pick **more** than one answer!)

- ☐ Nothing
- ☐ Fruit
- ☐ Vegetables
- ☐ Sandwiches
- ☐ Croissant, chocolate roll
- ☐ Rolls, bun, meusli bread
- ☐ Gingerbread, cracker
- ☐ Liga, Sultana
- ☐ Biscuits, cake
- ☐ Pie, muffin, pastry
- ☐ Candy, candy/chocolate-bars
- ☐ Chips, cheese, nuts
- ☐ Something else, namely: …

Supplement 3. Overview of items used to assess child's SSB intake in the parent and child questionnaire

<table>
<tr><th>Questionnaire items to assess child's SSB intake</th><th>Response categories</th></tr>
<tr><td colspan="2">Introduction to questions related child's SSB intake</td></tr>
<tr><td>Please indicate which of the drinks below your child (you) consume most of the times; this can be at school, at home or with friends.</td><td>☐ Coke/Pepsi
☐ Fanta/Sisi
☐ Fernandez
☐ Dr. Pepper
☐ Ice-tea
☐ Energy drinks (Redbull etc)
☐ Lemonade
☐ Apple juice
☐ Yoghurt-drinks
☐ Chocolate milk
☐ Tea with sugar</td></tr>
<tr><td colspan="2">All questions below are related to so-called sugar-sweetened beverages (SSB). These are beverages containing added sugar, sweetened dairy products (e.g., chocolate milk), fruit juice (e.g., apple juice), soft drinks (e.g., cola) and energy drinks (e.g., sport energy drinks).

All of the above examples of drinks are SSB.
Please fill in the questions below on how much SSB your child/you consume and keep above described definition and examples in mind.

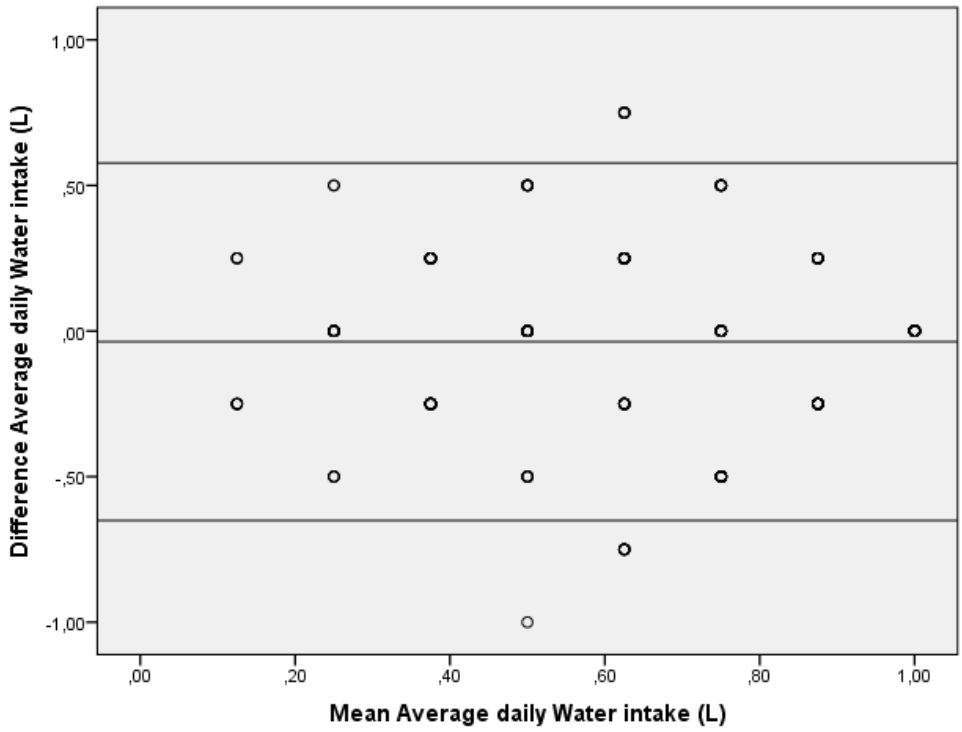
(So, do not take into account: light or sugar free beverages, water, 100% orange juice, tea without sugar, and regular milk.)</td></tr>
<tr><td>Does your child (do you) consume SSB on a daily basis?</td><td>☐ No, never
☐ No, not every day
☐ Yes, every day</td></tr>
<tr><td>Please indicate how many glasses (250ml – column A), cans (330ml – column B) or bottles (500ml – column C) the child (you) consumed on an average day on which the child drank SSB?</td><td>A. Glasses
 
☐ None
☐ 1 glass
☐ 2 glasses
☐ 3 glasses
☐ 4 glasses
☐ 5 glasses

B. Cans
 
☐ None
☐ 1 can
☐ 2 cans
☐ 3 cans
☐ 4 cans
☐ 5 cans

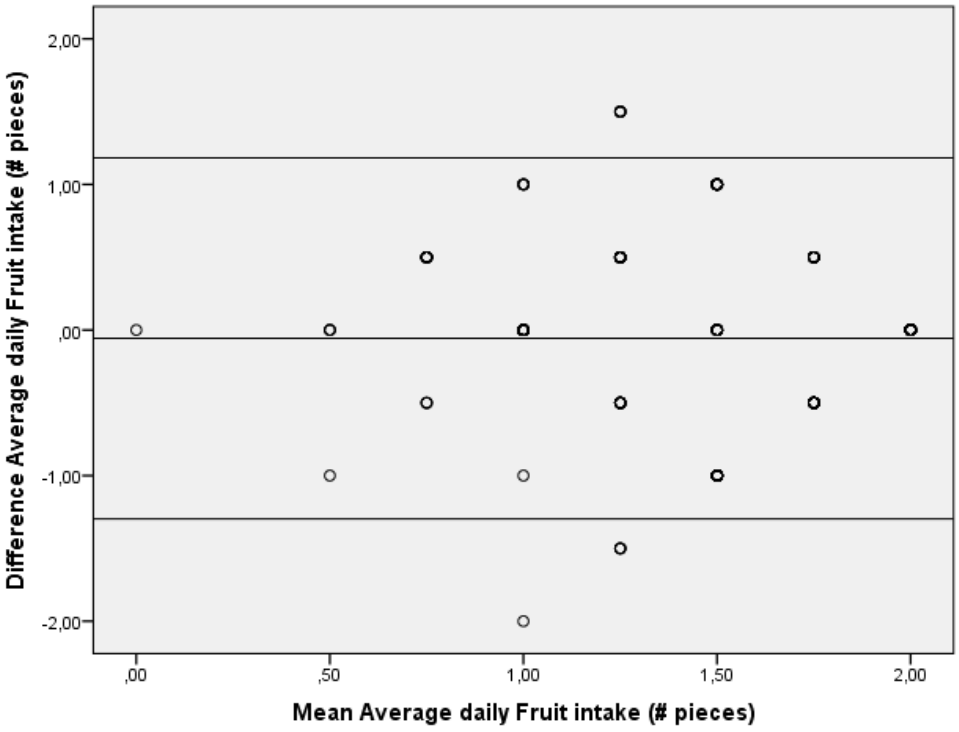
C. Bottles
 
☐ None
☐ 1 bottle
☐ 2 bottles
☐ 3 bottles
☐ 4 bottles
☐ 5 bottles</td></tr>
</table>

Supplement 4. Bland Altman plots

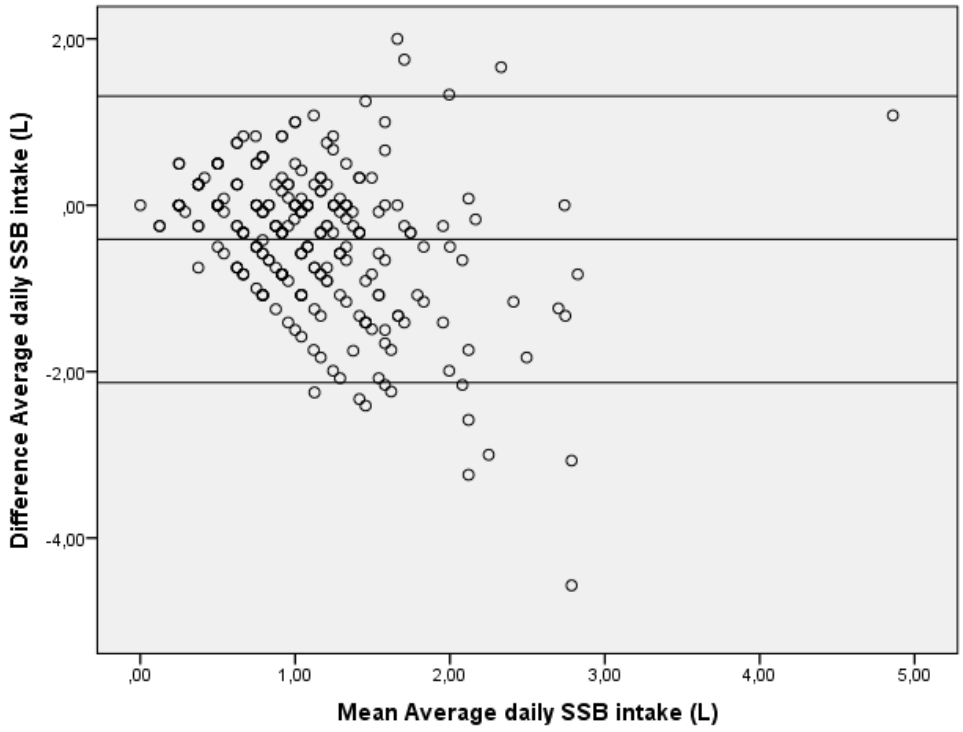
4a. Bland Altman plot – Water



4b. Bland Altman plot – Fruit



4c. Bland Altman plot – Sugar-sweetened beverages (SSB)



Supplement 5. STROBE 2007 (v4) Statement – Checklist of items that should be included in reports of *cross-sectional studies*

Section/ Topic	#	Recommendation	Reported on page #
Title and abstract			
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	26
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	26
Introduction			
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	27
Objectives	3	State specific objectives, including any prespecified hypotheses	27
Methods			
Study design	4	Present key elements of study design early in the paper	28
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	28-30
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	28-30
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	30-31
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	28-30
Bias	9	Describe any efforts to address potential sources of bias	na
Study size	10	Explain how the study size was arrived at	28-31
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	30-31
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	31
		(b) Describe any methods used to examine subgroups and interactions	na
		(c) Explain how missing data were addressed	na
		(d) If applicable, describe analytical methods taking account of sampling strategy	na
		(e) Describe any sensitivity analyses	na

Supplement 5 (continued)

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study – e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	32, Table 1
		(b) Give reasons for non-participation at each stage	na
		(c) Consider use of a flow diagram	Table 1
Descriptive data	14*	(a) Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders	32-34, Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	32-34, Tables 1-3
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included	34-34, Tables 2-3
		(b) Report category boundaries when continuous variables were categorized	na
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	na
Other analyses	17	Report other analyses done – e.g., analyses of subgroups and interactions, and sensitivity analyses	na
Discussion			
Key results	18	Summarise key results with reference to study objectives	36
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	39
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	36-40
Generalisability	21	Discuss the generalisability (external validity) of the study results	36-40
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	28

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Part II:

Determinants of health behaviours among children

5

Children's sugar-sweetened beverages consumption: Associations with family and home-related factors, differences within ethnic groups explored

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Abstract

Background: The consumption of sugar-sweetened beverages (SSB) may contribute to the development of overweight among children. The present study aimed to evaluate associations between family and home-related factors and children's SSB consumption. We explored associations within ethnic background of the child.

Methods: Cross-sectional data from the population-based 'Water Campaign' study were used. Parents (n=558) of primary school children (6 to 13 years old) completed a questionnaire on socio-demographic characteristics, family and home-related factors and child's SSB intake. The family and home-related factors under study were: cognitive variables (e.g., parental attitude, subjective norm), environmental variables (e.g., availability of SSB, parenting practices), and habitual variables (e.g., habit strength, taste preference). Regression analyses were used to evaluate the associations between family and home-related factors and child's SSB intake ($p<0.05$).

Results: Mean age of the children was 9.4 years (SD: 1.8) and 54.1% were girls. The child's average SSB intake was 0.9 litres (SD: 0.6) per day. Child's age, parents' subjective norm, parenting practices, and parental modelling were positively associated with the child's SSB intake. The availability of SSB at home and school and parental attitude were negatively associated with the child's SSB intake. The associations under study differed according to the child's ethnic background, with the explained variance of the full models ranging from 8.7% for children from Moroccan or Turkish ethnic background to 44.4% for children with Dutch ethnic background.

Conclusions: Our results provide support for interventions targeting children's SSB intake focussing on the identified family and home-related factors, with active participation of parents. Also, the relationships between these factors and the child's SSB intake differed for children with distinct ethnic backgrounds. Therefore, we would recommend to tailor interventions taking into account the ethnic background of the family.

Background

Consumption of sugar-sweetened beverages (SSB) among primary school children has been found to be positively associated with overweight and other health problems later in life [1-6]. To increase the effectiveness of interventions aiming to decrease children's SSB intake, it is necessary to identify the factors underlying their SSB consumption [7-9].

Cognitive models [10, 11] assist in providing an understanding of how behaviours such as SSB consumption develop as a result of cognitive factors such as attitude (i.e., behavioural beliefs), subjective norm (i.e., perceived social pressure) and perceived behavioural control (i.e., perceived ease or difficulty of performing the behaviour) [12, 13]. However, combined behavioural and environmental models like for instance the Environmental Research framework for weight Gain prevention (EnRG-framework) [14], indicate that physical or social environmental factors also influence health behaviours [15-18]. Parents, and consequently the home environment, play an essential role in establishing healthy behaviours for children [19-22]. Therefore, factors of interest include availability and accessibility of SSB at home, food rules and parenting practices (i.e., specific behaviours that parents use while/to raising their children), as well as parental involvement and role modelling [22, 23]. Additionally, it has been argued that habit strength (i.e., how strong a learned behavioural response is to a situational cue) and taste preferences (i.e., liking one food over another) are considered important factors to understand health behaviours [24-26]. Thus far, studies have yielded mixed results with regard to the associations between family and home-related factors and the child's SSB consumption [23, 27-36].

Overweight prevalence between children with certain ethnic backgrounds differs [37-40]. Consequently, awareness has been raised about potential differences regarding factors determining the child's SSB intake among families and children with different ethnic backgrounds [41-43]. More specifically, eating culture and parenting styles differ for families with diverse ethnic backgrounds [44, 45]. In addition, previous research shows that families from different ethnic minority groups may live in more (or less) obesogenic home environments, which subsequently may influence their healthy and unhealthy behaviours with respect to other demographic groups [46-50]. Brug and colleagues described that eating culture in relation to the child's food environment differs across countries in Europe and

that it is recommended to implement different strategies to improve healthy behaviours among children [43]. For instance, a study found that Dutch children consumed the most SSB compared to other European countries and that the SSB consumption of children living in countries with less SSB-friendly environments was lower [40].

Studies specifically focussing on evaluating the association between ethnic background (within one region) and family and home-related factors are lacking [46, 47], and non-existing within the Dutch multi-ethnic setting within the larger cities. According to Wyse and colleagues, their research among Australian preschool children showed the social-cultural environment (e.g., family eating patterns) as the most amendable to intervene [51]. Deepening our understanding of the associations within different ethnic groups will improve the ability to develop culturally appropriate interventions [52]. Based on their systematic review, Gubbels and colleagues emphasize that the next step within lifestyle research should be to differentiate and tailor interventions according to moderating factors described in the EnRG-framework to enhance interventions' effectiveness [53].

Therefore, insights into and understanding of the associations between family and home-related factors with child's health behaviour within different ethnic groups may contribute to the development of these interventions tailored to specific subgroups. In this study, the objective was to first study associations between family and home-related factors with child's SSB intake and second, to explore these associations within different ethnic groups. Our hypothesis was: the associations between family and home-related factors with child's SSB intake are different within distinct ethnic groups.

Methods

Study population and procedure

Our cross-sectional study used data from the population-based 'Water Campaign' study [54]. This controlled trial assessed the effects of a combined school- and community-based intervention on children's SSB consumption. The Medical and Ethical Review Committee of the Erasmus Medical Centre issued a 'declaration of no objection' (i.e., formal waver) for this study (reference number MEC-2011-183). Four primary schools located in multi-

ethnic neighbourhoods in Rotterdam, the Netherlands, were included in the study; two schools were included as intervention schools, two schools were included as control schools. Intervention and control schools were matched on number of pupils, socio-economic status and overweight prevalence. The included schools resulted from a convenience sample of schools participating in a municipal overweight intervention programme. Only schools in disadvantaged neighbourhoods were eligible for this intervention [54].

All children of grades 2 to 8 (aged 6 to 13 years old) within each of the four included schools were invited to participate, resulting in a total of 1288 invited children. Passive parental consent was obtained. Parents (and children) received a brochure with information to notify and inform them about the intervention and study participation. The study was also announced by the school, via the school letter and through the teachers and by flyers which were visible throughout the school. Parents (and children) were free to refuse participation without giving any explanation. They could do so by informing one of the teachers at their school or one of the researchers when present at school. At all times, the researchers could be contacted by a special phone-number or e-mail, for instance to decline participation [54]. Measurements were performed at baseline and after one year, using questionnaires (child and parental) and observations at school.

For the present study, data from the baseline parental questionnaire (administered March/April 2011) was used. A study population of 558 children (6 to 13 years old) was available for analyses.

Measures

Socio-demographic characteristics child and parent

The child's gender (boy/girl), age (years), and ethnic background were assessed. Ethnic background was defined by country of birth of the parents according to definitions given by Statistics Netherlands [55]. The child's ethnic background was defined as Dutch only if both parents had been born in the Netherlands; if one of the parents had been born in another country, ethnic background was defined according to that country; and if both parents had been born in different foreign countries, ethnic background was defined as

the mother's country of birth. Ethnic background was categorized as 'Dutch'; 'Surinamese/Antillean'; 'Moroccan/Turkish'; or 'other/unknown'.

Respondents were either the father or the mother of the child, and parental gender was based on this item (male/female). From this point onwards, respondent is described as 'parent'. Parental age (years) and educational level were also reported. Based on standard Dutch cut-off points, parents' highest achieved educational level was categorized as 'low' (no education; primary school; ≤3 years of general secondary school); 'mid-low' (>3 years of general secondary school); 'mid-high' (higher vocational training; undergraduate programs); or 'high' (higher academic education) [56].

In addition to the parental questionnaire, weight and height of the child were obtained by trained personnel. Weight status was determined by calculating the child's Body Mass Index (BMI) in kg/m^2 with height measured to the nearest 0.1cm and weight measured to the nearest 0.2kg, in light clothing or gym clothes, according to a national standardized protocol for Youth Health Care [57]. Children were categorized as being either 'non-overweight' or 'overweight/obese', based on BMI cut-off points published by the International Obesity Task Force [58].

Family and home-related factors

Table S1 in Supplement 1 provides an overview of the scales (and items) that were used to measure the family and home-related factors: (a) cognitive variables, (b) environmental variables, and (c) habitual variables. The measures of the cognitive variables and the environmental variables were based on the studies 'ENDORSE' and 'Be Active, Eat Right' [59, 60]. They were developed using the Theory of Planned Behaviour (TPB) as proposed by Ajzen [10]. The items were tailored to the consumption of SSB by children as suggested by Oluka et al. [61] and by Francis et al. [62]. The items used to measure the construct 'habit' were derived from the Self-Report Behavioural Automaticity index [63, 64].

Table S1 we report the percentages of missing answers per item and per scale as indicator of the feasibility of the measurements in our study. Scales were only computed when there were no missing data on any of the items. Table S1 also shows the Cronbach's alpha per scale to assess the internal consistency of each multi-item scale.

The cognitive variables assessed were parental attitude towards the child's SSB consumption (two items, Cronbach's α=0.84), parental attitude towards decreasing the child's SSB consumption (four items, Cronbach's α=0.70), parents' subjective norm towards the child's SSB consumption (one item), and the perceived behavioural control of parents towards having their child drink less SSB (two items, Cronbach's α=0.75). The percentage of missing values ranges from 2.6% to 7.6%; the internal consistency measured by Cronbach's alpha is ≥0.7 for two multi-item scales and >0.8 for one scale (all scales show 'good' internal consistency [65]).

The environmental variables assessed included the availability of SSB at home and school (two items, Cronbach's α=0.64), parenting practices towards the child's SSB intake (four items, Cronbach's α=0.74), rules at home with regard to the child's SSB intake (two items, Cronbach's α=0.77), and modelling of SSB consumption by the parents (one single item; and a two items-scale, Cronbach's α=0.72). The percentage of missing values ranges from 2.3% to 6.2%; the internal consistency measured by Cronbach's alpha is >0.7 for three of the multi-item scales (which is considered 'good'), and >0.6 for one scale (which is considered 'moderate' [65]).

The habitual variables assessed were habit strength of the child's SSB intake (four items, Cronbach's α=0.76) and taste preference of the child towards SSB (one item). The percentage of missing values ranges from 1.6% to 4.7%; the internal consistency measured by Cronbach's alpha is >0.7 for the multi-item scale (which is considered 'good' [65]).

All items measuring the family and home-related factors were assessed by using a five-point response scale, except for the questions regarding restriction rules for the child's SSB consumption (response scale 'yes'/'no'). All items were coded such that a higher score indicated more unfavourable behaviour (i.e., the child was expected to consume more SSB). The internal consistency of the multi-item scales was overall 'moderate' to 'good' (Cronbach's α>0.60) [65, 66]. The relatively low number of missing values supports the feasibility of the measures. We recommend further research regarding the validity of these measurement instruments in diverse populations.

SSB consumption

The following definition of SSB was used: beverages containing added sugar, sweetened dairy products (e.g., chocolate milk), fruit juices (e.g., apple juice), soft drinks (e.g., cola)

and energy drinks (e.g., sport energy drinks). Examples of SSB were provided along with the question based on our definition of SSB.

Average SSB consumption was assessed using the question 'On a day your child drinks SSB, how many glasses (250ml), cans (330ml) or bottles (500ml) does your child consume on average?'. Response categories ranged from 'none' to '5 or more'. The child's average SSB intake in litre per day was calculated by multiplying each reported glass, can and/or bottle with its volume and summed up thereafter.

Statistical analysis

Child and parental characteristics were analysed using descriptive statistics. Linear regression models were fitted. The dependent variable was the child's average SSB intake in litre per day. The family and home-related factors (cognitive, environmental and habitual variables) of SSB consumption were used as independent variables in the model.

The independent variables were entered in the model as blocks, correcting for other variables within this block. The first block that was entered in the model contained the socio-demographic characteristics (child's age, gender and ethnic background, and parental educational level); the second block contained the cognitive variables (parental attitude, parents' subjective norm, and perceived behavioural control); the third block contained the environmental variables (availability, parenting practices, rules, and parental modelling); and the fourth and final block contained the habitual variables (habit strength and child's taste preference). Finally, a full model was fitted with all independent variables. Beta's with 95% confidence intervals (95% CI) were estimated. The (adjusted) R square is presented to indicate the estimated amount of explained variance for each model. Results were considered significant at $p<0.05$ [66].

To explore differences in family and home-related factors according to ethnic background of the child, an interaction term was added to the model. Separately per block of variables (cognitive, environmental, and habitual) an interaction between ethnic background and the variable of interest was analysed, the model being only corrected for the variables in that block and not for any other (socio-demographic) variables. All interaction analyses are presented in Supplement 2; as shown in Table S2, several interactions differed statistically ($p<0.10$) [66]. Therefore, the previously mentioned full model was fitted

separately for the subgroups of children with a Dutch, Surinamese/Antillean, Moroccan/Turkish, and other/unknown ethnic background.

Analyses were conducted using SPSS version 22.0 (IBM Corp., Armonk, NY, USA).

Results

Study population characteristics

Mean age of the children was 9.4 years (SD: 1.8), 54.1% were girls, 30.3% were Dutch and 23.0% were overweight or obese. Parents' mean age was 37.0 years (SD: 8.9), 87.4% were female and 18.5% indicated to have completed a high level of education. According to the parents, the average SSB intake of the children was 0.9 litres per day (SD: 0.6) per day (Table 1).

Table 1 also shows the differences in socio-demographic variables and child's SSB intake for children from different ethnic backgrounds. For instance, differences were found between children with a Dutch ethnic background and children with a Surinamese or Antillean ethnic background with regard to average SSB intake: 0.7 litres per day (SD: 0.4) for Dutch children vs. 1.1 litres per day (SD: 0.9) for Surinamese or Antillean children ($p<0.05$).

Associations related to the child's SSB intake

Table 2 presents the results of the regression analyses evaluating the full model. The explained variance of the full model was 25.9% of the child's SSB intake.

Table 1: Child and parental characteristics for the overall sample and according to ethnic background of the child (n=644)

	Overall sample (n=644) % or Mean (SD)	Dutch (n=195) % or Mean (SD)	Surinamese/ Antillean (n=142) % or Mean (SD)	Moroccan /Turkish (n=185) % or Mean (SD)	Other/ unknown (n=119) % or Mean (SD)	*P*-value[a]
CHILD characteristics						
Gender, % girl *missing, n=12*	54.1%	55.2%	53.9%	50.0%	58.8%	0.500
Age (in years), mean (SD) *missing, n=6*	9.4 (1.8)	8.7 (1.8)	9.4 (1.8)	9.6 (1.6)	10.4 (1.6)	**0.000**
Ethnic background						
% Dutch	30.3%					
% Surinamese/ Antillean	22.0%					
% Moroccan/Turkish	28.9%					
% Other/unknown	18.8%					
Weight status, % over-weight or obese *missing, n=45*	23.0%	13.8%	26.1%	31.8%	21.1%	**0.001**
PARENTAL characteristics						
Gender, % female *missing, n=47*	87.4%	88.8%	94.8%	82.4%	84.0%	**0.007**
Age (in years), mean (SD) *missing, n=5*	37.0 (8.9)	37.3 (8.6)	36.7 (7.7)	36.4 (9.4)	37.6 (10.0)	0.655
Educational level *missing, n=21*						**0.000**
% Low	22.0%	10.6%	11.4%	41.2%	23.2%	
% Mid-low	25.0%	30.7%	23.6%	25.3%	17.0%	
% Mid-high	34.5%	32.3%	47.1%	24.7%	38.4%	
% High	18.5%	26.5%	17.9%	8.8%	21.4%	
SSB intake child						
Average SSB in litre per day, mean (SD) *missing, n=3*	0.9 (0.6)	0.7 (0.4)	1.1 (0.9)	0.8 (0.5)	0.9 (0.5)	**0.000**

a = differences between groups stratified for outcome measures, tested with one-way Anova (continuous variables) and Chi-square test (categorical variables).
Note: numbers printed in bold represent significant differences between the ethnic backgrounds groups.

Table 2: Results from the linear regression models evaluating the associations between family and home related factors and child's SSB intake in litre per day

	Model 1 (n=625)	Model 2 (n=570)	Model 3 (n=565)	Model 4 (n=611)	Model 5 (n=527)
	beta (95%CI)	beta (95%CI)	beta (95%CI)	beta (95%CI)	beta (95%CI)
Socio-demographic characteristics					
Gender child, boy=ref	-0.05 (-0.14;0.04)				-0.02 (-0.10;0.06)
Age child (in years)	**0.05 (0.02;0.08)*** **				**0.05 (0.02;0.07)*** **
Ethnic background child					
Dutch	- REF -				- REF -
Surinamese/ Antillean	**0.32 (0.19;0.44)*** **				**0.20 (0.08;0.31)****
Moroccan/Turkish	-0.02 (-0.15;0.10)				-0.01 (-0.12;0.10)
Other unknown	0.01 (-0.13;0.15)				0.01 (-0.11;0.14)
Educational level of parent					
Low	**0.15 (0.01;0.29)***				0.01 (-0.12;0.15)
Mid-low	-0.08 (-0.21;0.06)				-0.05 (-0.17;0.07)
Mid-high	**0.15 (0.03;0.28)***				0.08 (-0.04;0.19)
High	- REF -				- REF -
Cognitive variables[1]					
Attitude		**0.14 (0.06;0.21)*** **			0.04 (-0.04;0.12)
Attitude towards decreasing SSB		**-0.07 (-0.12;-0.01)***			**-0.08 (-0.14;-0.02)****
Subjective norm		**0.16 (0.11;0.21)*** **			**0.09 (0.04;0.15)*** **
Perceived behavioural control		**0.05 (0.00;0.10)***			-0.00 (-0.05;0.05)
Environmental variables[1]					
Availability			-0.03 (-0.06;0.01)		**-0.04 (-0.08;-0.01)***
Parenting practices			**0.21 (0.13;0.28)*** **		**0.13 (0.05;0.20)****
Rules			0.09 (-0.02;0.20)		0.06 (-0.04;0.17)
Modelling			**0.11 (0.07;0.15)*** **		**0.06 (0.02;0.10)****
Modelling *separate item*			0.01 (-0.02;0.04)		0.02 (-0.01;0.05)
Habitual variables[1]					
Habit strength				**0.20 (0.15;0.25)*** **	0.05 (-0.01;0.11)
Taste preference				0.01 (-0.04;0.06)	0.01 (-0.04;0.05)
R^2 (adjusted)[2]	**.095**	**.127**	**.163**	**.101**	**.259**

REF = reference category.

[1] Higher scores indicate expectation of more SSB consumption/higher score on unfavourable behaviour.

[2] R square statistic represents the estimated level of variance explained by the regression model.

Note: numbers printed in bold represent significant association between independent variable and average SSB consumption in litre per day of child in that model. Asterisks' represent the level of significance of the association between independent variable and outcome, corrected for all other variables: * p<0.05, ** p<0.01, *** p<0.001.

Child's SSB intake associations according to ethnic background of the child

Presented in Table 3 are the full models of the child's average SSB intake in litre per day separately for the four subgroups based on ethnic background. The explained variance of the full models ranged from 8.7% for children from Moroccan or Turkish ethnic background to 44.4% for children with a Dutch ethnic background.

The results are reported in accordance with STROBE (Strengthening the Reporting of Observational Studies in Epidemiology). See Supplement 3 for the STROBE checklist [67].

Table 3: Results from the full linear regression model evaluating the associations between family and home related factors and child's SSB intake in litre per day according to the ethnic background of the child

	Dutch (n=169)	Surinamese/ Antillean (n=112)	Moroccan/ Turkish (n=151)	Other/ unknown (n=95)
	Beta (95%CI)	Beta (95%CI)	Beta (95%CI)	Beta (95%CI)
Socio-demographic characteristics				
Gender child, boy=ref	-0.06 (-0.16;0.03)	0.14 (-0.13;0.41)	-0.09 (-0.23;0.05)	-0.05 (-0.23;0.13)
Age child (in years)	**0.03 (0.00;0.05)***	0.07 (-0.00;0.15)	0.04 (-0.00;0.08)	**0.08 (0.03;0.14)****
Educational level of parent				
Low	0.14 (-0.03;0.31)	-0.09 (-0.62;0.43)	0.03 (-0.20;0.26)	0.09 (-0.18;0.37)
Mid-low	-0.08 (-0.20;0.05)	-0.09 (-0.49;0.31)	-0.08 (-0.31;0.16)	0.12 (-0.18;0.41)
Mid-high	0.09 (-0.03;0.22)	0.07 (-0.28;0.42)	0.08 (-0.16;0.32)	0.10 (-0.15;0.34)
High	- REF -	- REF -	- REF -	- REF -
Cognitive variables[1]				
Attitude	**0.13 (0.03;0.24)***	0.04 (-0.27;0.34)	-0.02 (-0.15;0.12)	0.14 (-0.04;0.32)
Attitude towards decreasing SSB	0.00 (-0.07;0.08)	**-0.25 (-0.44;-0.05)***	-0.01 (-0.13;0.10)	-0.00 (-0.13;0.12)
Subjective norm	0.06 (-0.02;0.12)	0.19 (-0.01;0.38)	0.04 (-0.03;0.12)	**0.14 (0.02;0.26)***
Perceived behavioural control	-0.05 (-0.10;0.01)	0.03 (-0.16;0.22)	0.03 (-0.06;0.13)	-0.03 (-0.14;0.08)
Environmental variables[1]				
Availability	0.01 (-0.04;0.05)	-0.05 (-0.21;0.10)	**-0.07 (-0.13;-0.02)***	-0.00 (-0.10;0.09)
Parenting practices	**0.09 (0.01;0.18)***	0.26 (-0.01;0.52)	0.10 (-0.04;0.23)	-0.08 (-0.25;0.10)
Rules	-0.06 (-0.19;0.07)	0.15 (-0.19;0.48)	-0.12 (-0.31;0.07)	**0.39 (0.17;0.60)****
Modelling	**0.05 (0.01;0.09)***	0.07 (-0.09;0.22)	**0.08 (0.01;0.15)***	0.09 (-0.00;0.18)
- Modelling *separate item*	**0.03 (0.00;0.06)***	0.06 (-0.02;0.15)	-0.03 (-0.09;0.03)	0.01 (-0.06;0.07)
Habitual variables[1]				
Habit strength	**0.11 (0.05;0.17)****	0.01 (-0.21;0.23)	0.00 (-0.11;0.11)	0.06 (-0.11;0.22)
Taste preference	0.01 (-0.05;0.06)	-0.02 (-0.17;0.14)	0.01 (-0.07;0.10)	-0.09 (-0.20;0.03)
R^2 (adjusted)[2]	**.444**	**.278**	**.087**	**.249**

REF = reference category.
[1] Higher scores indicate expectation of more SSB consumption/higher score on unfavourable behaviour.
[2] R square statistic represents the estimated level of variance explained by the regression model.
Note: results from the full model with all independent variables; numbers printed in **bold** represent significant association between independent variable and **average SSB consumption in litre per day** of child. Asterisks' represent the level of significance of the association between independent variable and outcome, corrected for all other variables: * p<0.05, ** p<0.01, *** p<0.001.

Discussion

In this paper, we evaluated associations between family and home-related factors and children's SSB intake. Overall, child's age, parental attitude, parents' subjective norm, the availability of SSB at home and school, parenting practices and parental modelling showed to be associated with child's average SSB intake in litre per day. Associations between family and home-related factors with child's SSB intake differed for children with a Dutch, Surinamese/Antillean, Moroccan/Turkish, and other/unknown background.

In line with previous studies among children of similar age, we observed that children of parents who have a more positive attitude towards decreasing the child's SSB intake or children of parents with a more positive subjective norm towards their child's SSB intake, consumed less SSB [24, 28, 31, 59]. Also, children of parents who express healthier parenting practices towards the child's SSB intake (i.e., more restrictive towards the child's SSB consumption) and children of parents who less often model SSB consumption , are reported to have a lower SSB intake [18, 34, 41, 68, 69].

Contrary to other studies, we found that children consume less SSB when there is more SSB available in the home or school environment [29, 31, 33, 69]. This contradiction could be due to the cross-sectional nature of our study; children who already have high consumption levels might have less SSB available, following already implemented restrictions of their parents trying to improve the child's lifestyle.

The significant positive associations between parenting practices and parental modelling and the child's SSB consumption, emphasize the important role of parents in shaping the child's dietary habits [17, 20, 21, 33, 34, 52, 68]. Parents serve both as role model and as facilitator impacting children's consumption diet. To increase interventions' effectiveness, parents should be involved or specifically targeted as intervention participants [22, 36, 43, 68].

In this paper, we explored whether the associations between the family and home-related factors under study and the child's SSB intake differed according to ethnic background of the child. As Verzeletti emphasized, ethnic background differences may have an impact on parental beliefs regarding the child's SSB consumption or on rules restricting the intake of SSB by the child [41]. Our results provide support for this statement.

Children with a Dutch ethnic background showed positive associations between the child's SSB intake and parental attitude, parenting practices and parental modelling. Contrary to the model for all children together, our findings suggest that habit strength is an important determinant (only) for children with a Dutch ethnic background. Our model explained the most (44%) of the child's SSB intake for children with a Dutch ethnic background.

For children with a Surinamese or Antillean ethnic background, parental attitude towards decreasing the child's SSB intake was the only determinant that showed a significant association with the child's SSB consumption; the model explained almost 28% of the child's SSB consumption. We recommend future studies to explore factors that better explain the child's SSB consumption among this specific group. In the meantime, in order to decrease the child's SSB intake, special attention should be given to parental attitude when targeting children from Surinamese or Antillean ethnic background. For instance, health education as intervention element may be suggested as an element to change attitudes among these families [70].

Our model could explain just 9% of the child's SSB intake for children with a Moroccan or Turkish ethnic background. Given this small percentage of explained variance, we recommend future research to further explore and identify factors associated with child's SSB consumption. The two significant associations of factors with SSB consumption among Moroccan or Turkish children that were observed in the model appeared to be in the home environment (e.g., availability and modelling). Our results suggest that for children with a Moroccan or Turkish ethnic background, intervening on family level may be beneficial in order to reduce SSB consumption and not only improve the child's lifestyle but also that of the family. Especially with regard to the availability of SSB, the family (e.g., parents) are responsible for buying SSB and determine to what extent SSB is provided to their child. Also parents' modelling behaviour could be addressed in these family level interventions, for instance by including skills training and role play in the intervention [70].

For children with an 'other or unknown' ethnic background, the model explained almost 25%. However, interpretation of the results is difficult because of the varied composition of children in this group. It included for example children with non-Western (e.g., Afghanistan) and Western background (e.g., Germany). We have no explanation for the

association between child's age, parents' subjective norm and rules at home and the child's SSB intake.

Our results provide support for differences in the association between family and home-related factors and the child's SSB intake according to the ethnic background of the child. Further research is needed to increase our understanding of these differences. It has been suggested that associations between demographic factors and health-related behaviours as were found in this study, might be due to differences in health literacy [71]. How well people understand and can act on health-related information has shown to be associated with healthy lifestyles [72]. Caregiver's health literacy has been associated with their own and their children's' health outcomes [73-77]. Increased understanding of these factors and underlying mechanisms that possibly can explain the children's lifestyle behaviours between subgroups could assist to further tailor and improve interventions, in order to enhance interventions' effectiveness.

Methodological considerations

Evaluating the child's SSB intake by means of a continuous measure, average consumption in litre per day is considered a strength of this study. Because of the possibility of information loss, using a continuous measure is preferred above transforming the measure into a dichotomous variable. However, seen by other studies, SSB intake is often reported dichotomously as ≤2 vs >2 SSB servings per day. When conducting the analyses with child's intake in ≤2 vs >2 SSB servings per day as outcome measure, we observed similar associations between family and home-related factors and child's SSB intake (both for the overall analyses as when exploring between children with different ethnic backgrounds; see Supplement 4, Tables S3-S6). The diverse population with children from various ethnic backgrounds and a response of 54.8% on the parent questionnaire (given the diverse population) are also strengths that have to be mentioned.

However, some limitations of the present study need to be addressed. We relied on parental self-reports, which is a commonly used way to assess children's intake. Though there is a possibility that parents may have provided socially desirable answers, parent reports are seen as one of the most accurate methods to estimate a child's intake (in the

ages 4 to 11 years old) [78]. Children's weight and height were measured by trained health professionals, applying a standardised protocol for Youth Health Care [57]. The measurements of family and home-related factors were based on the TPB and tailored to the consumption of SSB by children, as suggested by Oluka et al. [61] and Francis et al. [62]. In our study, the Cronbach's alphas indicate 'moderate' to 'good' reliability of the multi-item scales. We recommend further research regarding the validity of these measurement instruments in multi-ethnic populations. Given the cross-sectional design of our study, inferences regarding cause and effect are not possible. It is recommended to explore and test our findings for causal inferences in longitudinal or experimental intervention studies. Also, the study was conducted in multi-ethnic inner-city neighbourhoods. The generalizability of our study findings might therefore be limited to children belonging to similar populations and settings.

Conclusions

This paper provided insight into factors related to children's SSB consumption. We observed that the child's age, parental attitude, parents' subjective norm, the availability of SSB at home and school, parenting practices, parental modelling were associated with the child's SSB consumption (in litre per day). These findings provide support for interventions to focus on parents and improve their (family) lifestyle in order to promote the transference of healthy behaviours to the children.

Moreover, we observed differences with respect to the associations between family and home-related factors and child's SSB consumption for children with a Dutch, Surinamese/Antillean, Moroccan/Turkish, and other/unknown background. Therefore, further understanding of the factors of health behaviour of different target segments should be endorsed, through observational, qualitative research and quantitative research as well as longitudinal studies replicating our findings. By identifying the most important factors per target segment intervention effectiveness may be improved. In the meantime, we recommend intervention developers and behaviour change agents in the field to take relevant differences into account when developing tailored interventions within multi-ethnic communities.

References

1. Ludwig DS, Peterson KE, Gortmaker SL. Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet* 2001; **357**(9255)**:** 505-8.
2. Olsen NJ, Heitmann BL. Intake of calorically sweetened beverages and obesity. *Obes Rev* 2009; **10**(1)**:** 68-75.
3. Vartanian LR, Schwartz MB, Brownell KD. Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. *Am J Public Health* 2007; **97**(4)**:** 667-75.
4. de Ruyter JC, Olthof MR, Seidell JC, Katan MB. A trial of sugar-free or sugar-sweetened beverages and body weight in children. *N Engl J Med* 2012; **367**(15)**:** 1397-406.
5. Malik VS, Pan A, Willett WC, Hu FB. Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. *Am J Clin Nutr* 2013; **98**(4)**:** 1084-102.
6. Wang M, Yu M, Fang L, Hu RY. Association between sugar-sweetened beverages and type 2 diabetes: A meta-analysis. *J Diabetes Investig* 2015; **6**(3)**:** 360-6.
7. Baranowski T. *Handbook of Health Behavior Research I: Personal and Social Determinants.*, Plenum Press: New York, 1997.
8. Baranowski T, Cullen KW, Nicklas T, Thompson D, Baranowski J. Are current health behavioral change models helpful in guiding prevention of weight gain efforts? *Obes Res* 2003; **11 Suppl:** 23S-43S.
9. Glanz K RBLF. *Health Behavior and Health Education: Theory, Research and Practice.*, Jossey-Bass: San Francisco, CA, 2002.
10. Ajzen I. The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes* 1991; **50**(2)**:** 179-211.
11. Bandura A. *Self-efficacy. The exercise of control.*, Freeman: New York, 1997.
12. Kassem NO, Lee JW. Understanding soft drink consumption among male adolescents using the theory of planned behavior. *J Behav Med* 2004; **27**(3)**:** 273-96.
13. Kassem NO, Lee JW, Modeste NN, Johnston PK. Understanding soft drink consumption among female adolescents using the Theory of Planned Behavior. *Health Educ Res* 2003; **18**(3)**:** 278-91.
14. Kremers SP, de Bruijn GJ, Visscher TL, 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.
15. Egger G, Swinburn B. An "ecological" approach to the obesity pandemic. *BMJ* 1997; **315**(7106)**:** 477-80.
16. Brug J, van Lenthe FJ, Kremers SP. Revisiting Kurt Lewin: how to gain insight into environmental correlates of obesogenic behaviors. *Am J Prev Med* 2006; **31**(6)**:** 525-9.

17. van der Horst K, Oenema A, Ferreira I, Wendel-Vos W, Giskes K, van Lenthe F *et al.* A systematic review of environmental correlates of obesity-related dietary behaviors in youth. *Health Educ Res* 2007; **22**(2)**:** 203-26.

18. 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**(8)**:** 1380-95.

19. Birch LL, Fisher JO. Development of eating behaviors among children and adolescents. *Pediatrics* 1998; **101**(3 Pt 2)**:** 539-49.

20. Golan M, Crow S. Parents are key players in the prevention and treatment of weight-related problems. *Nutr Rev* 2004; **62**(1)**:** 39-50.

21. Rosenkranz RR, Dzewaltowski DA. Model of the home food environment pertaining to childhood obesity. *Nutr Rev* 2008; **66**(3)**:** 123-40.

22. De Craemer M, De Decker E, De Bourdeaudhuij I, Vereecken C, Deforche B, Manios Y *et al.* Correlates of energy balance-related behaviours in preschool children: a systematic review. *Obes Rev* 2012; **13 Suppl 1:** 13-28.

23. Bere E, Glomnes ES, te Velde SJ, Klepp KI. Determinants of adolescents' soft drink consumption. *Public Health Nutr* 2008; **11**(1)**:** 49-56.

24. Grimm GC, Harnack L, Story M. Factors associated with soft drink consumption in school-aged children. *J Am Diet Assoc* 2004; **104**(8)**:** 1244-9.

25. Aarts H, Paulussen T, Schaalma H. Physical exercise habit: on the conceptualization and formation of habitual health behaviours. *Health Educ Res* 1997; **12**(3)**:** 363-74.

26. van der Horst K, Kremers S, Ferreira I, Singh A, Oenema A, Brug J. Perceived parenting style and practices and the consumption of sugar-sweetened beverages by adolescents. *Health Educ Res* 2007; **22**(2)**:** 295-304.

27. Haerens L, Craeynest M, Deforche B, Maes L, Cardon G, De Bourdeaudhuij I. The contribution of psychosocial and home environmental factors in explaining eating behaviours in adolescents. *Eur J Clin Nutr* 2008; **62**(1)**:** 51-9.

28. de Bruijn GJ, Kremers SP, de Vries H, van Mechelen W, Brug J. Associations of social-environmental and individual-level factors with adolescent soft drink consumption: results from the SMILE study. *Health Educ Res* 2007; **22**(2)**:** 227-37.

29. 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**(2)**:** 202-11.

30. Tak NI, Te Velde SJ, Oenema A, Van der Horst K, Timperio A, Crawford D *et al.* The association between home environmental variables and soft drink consumption among adolescents. Exploration of mediation by individual cognitions and habit strength. *Appetite* 2011; **56**(2)**:** 503-10.

31. Ezendam NP, Evans AE, Stigler MH, Brug J, Oenema A. Cognitive and home environmental predictors of change in sugar-sweetened beverage consumption among adolescents. *Br J Nutr* 2010; **103**(5)**:** 768-74.

32. Vagstrand K, Linne Y, Karlsson J, Elfhag K, Lindroos AK. Correlates of soft drink and fruit juice consumption among Swedish adolescents. *Br J Nutr* 2009; **101**(10)**:** 1541-8.

33. Van Lippevelde W, te Velde SJ, Verloigne M, De Bourdeaudhuij I, Manios Y, Bere E *et al.* 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**(1)**:** 59-65.

34. 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**(1)**:** 76-80.

35. Vereecken CA, Inchley J, Subramanian SV, Hublet A, Maes L. The relative influence of individual and contextual socio-economic status on consumption of fruit and soft drinks among adolescents in Europe. *Eur J Public Health* 2005; **15**(3)**:** 224-32.

36. Mazarello Paes V, Hesketh K, O'Malley C, Moore H, Summerbell C, Griffin S *et al.* Determinants of sugar-sweetened beverages in young children: a systematic review. *Obes Rev* 2015; **16:** 903-913.

37. Schonbeck Y, Talma H, van Dommelen P, Bakker B, Buitendijk SE, Hirasing RA *et al.* Increase in prevalence of overweight in Dutch children and adolescents: a comparison of nationwide growth studies in 1980, 1997 and 2009. *PLoS ONE* 2011; **6**(11)**:** e27608.

38. van Dommelen P, Schonbeck Y, van Buuren S, Hirasing RA. Trends in a life threatening condition: morbid obesity in dutch, Turkish and moroccan children in the Netherlands. *PLoS ONE* 2014; **9**(4)**:** e94299.

39. Fredriks AM, Van Buuren S, Sing RA, Wit JM, Verloove-Vanhorick SP. Alarming prevalences of overweight and obesity for children of Turkish, Moroccan and Dutch origin in The Netherlands according to international standards. *Acta Paediatr* 2005; **94**(4)**:** 496-8.

40. Brug J, van Stralen MM, Te Velde SJ, Chinapaw MJ, De Bourdeaudhuij I, Lien N *et al.* Differences in weight status and energy-balance related behaviors among schoolchildren across Europe: the ENERGY-project. *PLoS ONE* 2012; **7**(4)**:** e34742.

41. Verzeletti C, Maes L, Santinello M, Vereecken CA. 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**(3)**:** 312-7.

42. van der Horst K, Oenema A, te Velde SJ, Brug J. Gender, ethnic and school type differences in overweight and energy balance-related behaviours among Dutch adolescents. *Int J Pediatr Obes* 2009; **4**(4)**:** 371-80.

43. te Velde SJ, Singh A, Chinapaw M, De Bourdeaudhuij I, Jan N, Kovacs E *et al.* Energy balance related behaviour: personal, home- and friend-related factors among schoolchildren in Europe studied in the ENERGY-project. *PLoS ONE* 2014; **9**(11)**:** e111775.

44. Varela RE, Vernberg EM, Sanchez-Sosa JJ, Riveros A, Mitchell M, Mashunkashey J. Parenting style of Mexican, Mexican American, and Caucasian-non-Hispanic families: social context and cultural influences. *J Fam Psychol* 2004; **18**(4)**:** 651-7.

45. Brug J, van Stralen MM, Chinapaw MJ, De Bourdeaudhuij I, Lien N, Bere E *et al.* 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; **7**(5)**:** 399-411.

46. Chuang RJ, Sharma S, Skala K, Evans A. Ethnic differences in the home environment and physical activity behaviors among low-income, minority preschoolers in Texas. *Am J Health Promot* 2013; **27**(4)**:** 270-8.

47. Skala K, Chuang RJ, Evans A, Hedberg AM, Dave J, Sharma S. Ethnic differences in the home food environment and parental food practices among families of low-income Hispanic and African-American preschoolers. *J Immigr Minor Health* 2012; **14**(6)**:** 1014-22.

48. Schrempft S, van Jaarsveld CH, Fisher A, Wardle J. The Obesogenic Quality of the Home Environment: Associations with Diet, Physical Activity, TV Viewing, and BMI in Preschool Children. *PLoS ONE* 2015; **10**(8)**:** e0134490.

49. Shrewsbury V, Wardle J. Socioeconomic status and adiposity in childhood: a systematic review of cross-sectional studies 1990-2005. *Obesity (Silver Spring)* 2008; **16**(2)**:** 275-84.

50. van Ansem WJ, van Lenthe FJ, Schrijvers CT, 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**(3)**:** 467-76.

51. Wyse R, Campbell E, Nathan N, Wolfenden L. Associations between characteristics of the home food environment and fruit and vegetable intake in preschool children: a cross-sectional study. *BMC Public Health* 2011; **11:** 938.

52. Conlon BA, McGinn AP, Lounsbury DW, Diamantis PM, Groisman-Perelstein AE, Wylie-Rosett J *et al.* The Role of Parenting Practices in the Home Environment among Underserved Youth. *Child Obes* 2015; **11**(4)**:** 394-405.

53. 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.

54. van de Gaar VM, Jansen W, van Grieken A, Borsboom G, Kremers S, Raat H. Effects of an intervention aimed at reducing the intake of sugar-sweetened beverages in primary school children: a controlled trial. *Int J Behav Nutr Phys Act* 2014; **11:** 98.

55. Swertz O, Duimelaar P, Thijssen J. *Statistics Netherlands. Migrants in the Netherlands 2004.* Statistics Netherlands: Voorburg/Heerlen, the Netherlands, 2004.

56. *Dutch Standard Classification of Education 2003.* Statistics Netherlands: Voorburg/Heerlen, Netherlands, 2004.

57. Bulk-Bunschoten AMW, Renders CM, Leerdam FJM, Hirasing RA. *Protocol for detection of overweight in preventive youth health care. [Signaleringsprotocol overgewicht in de jeugdgezondheidszorg]*. VUMC: Amsterdam, 2004.

58. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000; **320**(7244)**:** 1240-3.

59. 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.

60. Veldhuis L, Struijk MK, Kroeze W, Oenema A, Renders CM, Bulk-Bunschoten AM *et al.* 'Be active, eat right', evaluation of an overweight prevention protocol among 5-year-old children: design of a cluster randomised controlled trial. *BMC Public Health* 2009; **9:** 177.

61. Oluka OC, Nie S, Sun Y. Quality assessment of TPB-based questionnaires: a systematic review. *PLoS ONE* 2014; **9**(4)**:** e94419.

62. Francis J, Eccles MP, Johnston M, Walker AE, Grimshaw JM, Foy R *et al. Constructing questionnaires based on the theory of planned behaviour: A manual for health services researchers.* . Centre for Health Services Research, University of Newcastle: Newcastle, United Kingdom, 2004.

63. Gardner B, Abraham C, Lally P, de Bruijn GJ. Towards parsimony in habit measurement: testing the convergent and predictive validity of an automaticity subscale of the Self-Report Habit Index. *Int J Behav Nutr Phys Act* 2012; **9:** 102.

64. Verplanken B, Orbell S. Reflections on Past Behavior: A Self-Report Index of Habit Strength. *Journal of Applied Social Psychology* 2003; **33**(6)**:** 8.

65. de Vet HC, Terwee CB, Knol DL, Bouter LM. When to use agreement versus reliability measures. *J Clin Epidemiol* 2006; **59**(10)**:** 1033-9.

66. Field A. *Discovering Statistics Using SPSS*, vol. Second Edition. SAGE Publications: London, 2005.

67. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP *et al.* The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* 2007; **370**(9596)**:** 1453-7.

68. Bauer KW, Neumark-Sztainer D, Fulkerson JA, Hannan PJ, Story M. Familial correlates of adolescent girls' physical activity, television use, dietary intake, weight, and body composition. *Int J Behav Nutr Phys Act* 2011; **8:** 25.

69. van Grieken A, Renders CM, van de Gaar VM, Hirasing RA, Raat H. Associations between the home environment and children's sweet beverage consumption at 2-year follow-up: the 'Be active, eat right' study. *Pediatr Obes* 2015; **10**(2)**:** 126-33.

70. Bartholomew LK, Parcel GS, Kok G, Gottlieb NH, Fernandez ME. *Planning health promotion programs, an intervention mapping approach*, 3rd edn Jossey-Bass: Francisco, California, 2011.

71. Paasche-Orlow MK, Wolf MS. The causal pathways linking health literacy to health outcomes. *Am J Health Behav* 2007; **31 Suppl 1:** S19-26.

72. Geboers B, de Winter AF, Luten KA, Jansen CJ, Reijneveld SA. The association of health literacy with physical activity and nutritional behavior in older adults, and its social cognitive mediators. *J Health Commun* 2014; **19 Suppl 2:** 61-76.

73. Speirs KE, Messina LA, Munger AL, Grutzmacher SK. Health literacy and nutrition behaviors among low-income adults. *J Health Care Poor Underserved* 2012; **23**(3)**:** 1082-91.

74. von Wagner C, Knight K, Steptoe A, Wardle J. Functional health literacy and health-promoting behaviour in a national sample of British adults. *J Epidemiol Community Health* 2007; **61**(12)**:** 1086-90.

75. Sanders LM, Federico S, Klass P, Abrams MA, Dreyer B. Literacy and child health: a systematic review. *Arch Pediatr Adolesc Med* 2009; **163**(2)**:** 131-40.

76. Morrison AK, Schapira MM, Gorelick MH, Hoffmann RG, Brousseau DC. Low caregiver health literacy is associated with higher pediatric emergency department use and nonurgent visits. *Acad Pediatr* 2014; **14**(3)**:** 309-14.

77. Morrison AK, Myrvik MP, Brousseau DC, Hoffmann RG, Stanley RM. The relationship between parent health literacy and pediatric emergency department utilization: a systematic review. *Acad Pediatr* 2013; **13**(5)**:** 421-9.

78. Burrows TL, Martin RJ, Collins CE. A systematic review of the validity of dietary assessment methods in children when compared with the method of doubly labeled water. *J Am Diet Assoc* 2010; **110**(10)**:** 1501-10.

Supplements

Supplement 1. Table S1: Descriptive results and scale information for the family and home-related factors (n=644)

	General information		Scale information		(Example of) Questionnaire item
	n (%)	Mean (SD)	# items	Cronbach's α (stand.)	
Cognitive variables[1]					
Parental attitude towards child's SSB intake *(range 1-5)*	625 (97.0%)	3.0 (0.6)	2	0.8	e.g., "When my child drinks SSB, I find it…" (pleasant – not so pleasant)
Parental attitude towards decreasing child's SSB intake *(range 1-5)*	595 (92.4%)	2.2 (0.8)	4	0.7	e.g., "I believe my child should consume less SSB." (agree – disagree)
Parents subjective norm towards the child's SSB intake *(range 1-5)*	627 (97.4%)	2.3 (0.9)	1	-	i.e., "When comparing your child with other children of his/her age, does your child consume more or less SSB?" (more – less)
Perceived behavioural control of parents towards having their child drink less SSB *(range 1-5)*	625 (97.0%)	2.3 (0.9)	2	0.8	e.g., "Does it seem difficult or easy to let your child drink less SSB?" (difficult – easy)
Environmental variables[1]					
Availability of SSB at home/school *(range 1-5)*	629 (97.7%)	3.7 (1.3)	2	0.6	e.g., "SSB's are usually available for my child at home." (agree – disagree)
Parenting practices towards child's SSB intake *(range 1-5)*	625 (97.0%)	2.7 (0.7)	4	0.7	e.g., "To what extent do you monitor how often your child drinks SSB?" (never–always)
Rules at home with regard to child's SSB intake *(range 1-2)*	624 (96.9%)	1.4 (0.4)	2	0.8	e.g., "Are there in your home rules about how many SSB your child may consume?" (yes-no)
Modelling of SBB intake by the parents *(range 1-5)*	617 (95.8%)	2.6 (1.2)	2	0.7	e.g., "How often do you (or your partner) drink SSB together with your child? (never – every day, multiple times)
- Separate item 'Parental Modelling' *(range 1-5)*	604 (93.8%)	2.5 (1.5)	1	-	i.e., "Does your partner consume SSB often?" (never – always)
Habitual variables[1]					
Habit strength of the child's SSB intake *(range 1-5)*	614 (95.3%)	3.0 (0.9)	4	0.8	e.g., "My child often drinks SSB without thinking about it." (agree – disagree)
Taste preference of child towards SSB *(range 1-5)*	634 (98.4%)	4.3 (1.0)	1	-	i.e., "My child likes the taste of SSB." (agree – disagree)

[1] Higher scores indicate expectation of more SSB consumption/a higher score on unfavourable behaviour.

Supplement 2. Table S2: *P*-values for interaction between ethnic background and the determinants on child's SSB intake in litre per day* (n=644)

	SSB in litre		
	***P*-value Dutch vs Surinamese/ Antillean**	***P*-value Dutch vs Moroccan/ Turkish**	***P*-value Dutch vs Other/ unknown**
Cognitive variables[1]			
Parental attitude towards child's SSB intake *(range 1-5)*	*NS*	0.003	*NS*
Parental attitude towards decreasing child's SSB intake *(range 1-5)*	0.002	*NS*	*NS*
Parents subjective norm towards the child's SSB intake *(range 1-5)*	0.009	*NS*	*NS*
Perceived behavioural control of parents towards having their child drink less SSB *(range 1-5)*	0.002	*NS*	*NS*
Environmental variables[1]			
Availability of SSB ate home/school *(range 1-5)*	*NS*	0.014	*NS*
Parenting practices towards child's SSB intake *(range 1-5)*	<0.001	*NS*	*NS*
Rules at home with regard to child's SSB intake *(range 1-2)*	0.001	*NS*	0.007
Modelling of SBB intake by the parents *(range 1-5)*	0.073	*NS*	*NS*
- Separate item 'Parental Modelling' *(range 1-5)*	*NS*	*NS*	*NS*
Habitual variables[1]			
Habit strength of the child's SSB intake *(range 1-5)*	0.059	0.011	*NS*
Taste preference of child towards SSB *(range 1-5)*	*NS*	*NS*	*NS*

*****Separately per block of variables (cognitive, environmental, and habitual) the interaction was analysed tested with one-way Anova (continuous variables) and Chi-square test (categorical variables), being only corrected for the variables in that block and not for any other variables or socio-demographic variables. As seen in this Table S2, several interactions differed statistically (p<0.10).
NS = not significant (p>0.10).
[1]Higher scores indicate the expectation of more SSB consumption/a higher score on unfavourable behaviour.

Supplement 3. STROBE 2007 (v4) Statement – Checklist of items that should be included in reports of *cross-sectional studies*

Section/ Topic	#	Recommendation	Reported on page #
Title and abstract			
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	56
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	56
Introduction			
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	57
Objectives	3	State specific objectives, including any prespecified hypotheses	57
Methods			
Study design	4	Present key elements of study design early in the paper	58
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	58
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	58-59
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	59-61
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	59- 62
Bias	9	Describe any efforts to address potential sources of bias	na
Study size	10	Explain how the study size was arrived at	62
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	59-62
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	62
		(b) Describe any methods used to examine subgroups and interactions	62, Tables S2, S4
		(c) Explain how missing data were addressed	60
		(d) If applicable, describe analytical methods taking account of sampling strategy	na
		(e) Describe any sensitivity analyses	na

Supplement 3 (continued)

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study – e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	60-63, Table 1
		(b) Give reasons for non-participation at each stage	na
		(c) Consider use of a flow diagram	Table 1
Descriptive data	14*	(a) Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders	63, Table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	63-63, Tables 1-3
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included	63-66, Tables 2-3
		(b) Report category boundaries when continuous variables were categorized	70, Tables S3-S6
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	na
Other analyses	17	Report other analyses done – e.g., analyses of subgroups and interactions, and sensitivity analyses	63-66, Tables 3, S2-S4, S6
Discussion			
Key results	18	Summarise key results with reference to study objectives	68-71
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	70
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	68-71
Generalisability	21	Discuss the generalisability (external validity) of the study results	68-71
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	58

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Supplement 4. Analyses with child's intake in ≤2 vs >2 SSB servings per day as outcome measure

Table S3: SSB intake in servings per day for the overall sample and according to ethnic background of the child (n=644)

	Overall sample (n=644) % or mean (SD)	Dutch (n=195) % or mean (SD)	Surinamese/ Antillean (n=142) % or mean (SD)	Moroccan/ Turkish (n=185) % or mean (SD)	Other/ unknown (n=119) % or mean (SD)	*P*-value[a]
SSB intake child						
>2 SSB servings per day, % yes	59.3%	54.9%	71.8%	55.7%	57.1%	**0.007**

a = differences between groups stratified for outcome measures, tested with one-way Anova (continuous variables) and Chi-square test (categorical variables).
Note: numbers printed in bold represent significant differences between the ethnic backgrounds groups.

Table S4: P-values for interaction between ethnic background and the determinants on child's SSB intake in servings per day* (n=644)

	SSB servings		
	***P*-value Dutch vs Surinamese/ Antillean**	***P*-value Dutch vs Moroccan/ Turkish**	***P*-value Dutch vs Other/ unknown**
Cognitive variables[1]			
Parental attitude towards child's SSB intake *(range 1-5)*	0.002	0.003	0.011
Parental attitude towards decreasing child's SSB intake *(range 1-5)*	*NS*	*NS*	*NS*
Parents subjective norm towards the child's SSB intake *(range 1-5)*	*NS*	*NS*	*NS*
Perceived behavioural control of parents towards having their child drink less SSB *(range 1-5)*	*NS*	*NS*	*NS*
Environmental variables[1]			
Availability of SSB ate home/school *(range 1-5)*	*NS*	0.022	0.080
Parenting practices towards child's SSB intake *(range 1-5)*	*NS*	*NS*	*NS*
Rules at home with regard to child's SSB intake *(range 1-2)*	*NS*	*NS*	0.032
Modelling of SBB intake by the parents *(range 1-5)*	*NS*	0.066	0.065
- Separate item 'Parental Modelling' *(range 1-5)*	0.088	*NS*	*NS*
Habitual variables[1]			
Habit strength of the child's SSB intake *(range 1-5)*	*NS*	<0.001	*NS*
Taste preference of child towards SSB *(range 1-5)*	*NS*	*NS*	*NS*

*****Separately per block of variables (cognitive, environmental, and habitual) the interaction was analysed, being only corrected for the variables in that block and not for any other variables or socio-demographic variables. As seen in this Table S4, several interactions differed statistically (p<0.10).
NS = not significant (p>0.10).
[1]Higher scores indicate the expectation of more SSB consumption/a higher score on unfavourable behaviour.

Table S5: Results from the logistic regression models evaluating the associations between family and home related factors and child's SSB intake in servings per day (≤2 vs >2)

	Model 1 (n=604)	Model 2 (n=570)	Model 3 (n=565)	Model 4 (n=611)	Model 5 (n=516)
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Socio-demographic characteristics					
Gender child, boy=ref	**0.65 (0.46;0.92)***				0.75 (0.49;1.14)
Age child (in years)	**1.21 (1.09;1.34)*****				**1.27 (1.11;1.44)*****
Ethnic background child					
Dutch	- REF -				- REF -
Surinamese/ Antillean	1.52 (0.93;2.50)				1.11 (0.60;2.05)
Moroccan/ Turkish	**0.61 (0.38;0.98)***				0.61 (0.34;1.10)
Other/ unknown	0.64 (0.37;1.09)				0.55 (0.28;1.07)
Educational level of parent					
Low	**3.30 (1.87;5.83)*****				**2.20 (1.10;4.42)***
Mid-low	1.30 (0.78;2.15)				1.23 (0.66;2.30)
Mid-high	**3.10 (1.89;5.08)*****				**2.31 (1.26;4.22)****
High	- REF -				- REF -
Cognitive variables[1]					
Attitude		**1.48 (1.08;2.04)***			0.74 (0.48;1.14)
Attitude towards decreasing SSB		0.84 (0.66;1.06)			0.93 (0.69;1.26)
Subjective norm		**1.96 (1.55;2.48)*****			**1.62 (1.22;2.14)****
Perceived behavioural control		1.04 (0.84;1.27)			0.80 (0.60;1.05)
Environmental variables[1]					
Availability			1.04 (0.90;1.21)		0.98 (0.81;1.19)
Parenting practices			**1.84 (1.32;2.56)*****		**1.54 (1.04;2.28)***

Table S5 (continued)

Rules			1.60 (0.98;2.60)		1.31 (0.75;2.29)
Modelling			**1.78 (1.47;2.14)*** **		**1.60 (1.29;1.98)*** **
- Modelling *separate item*			0.90 (0.79;1.03)		0.94 (0.81;1.09)
Habitual variables[1]					
Habit strength				**2.08 (1.68;2.56)*** **	**1.49 (1.08;2.06)***
Taste preference				0.92 (0.76;1.13)	1.01 (0.79;1.30)
Nagelkerke R^2 (adjusted)[2]	**.133**	**.126**	**.222**	**.121**	**.330**

REF = reference category.
[1] Higher scores indicate expectation of more SSB consumption/higher score on unfavourable behaviour.
[2] Nagelkerke R square statistic represents the estimated level of variance explained by the regression model.
Note: numbers printed in bold represent significant association between independent variable and ≤2 vs >2 SSB intake in servings per day of child in that model. Asterisks' represent the level of significance of the association between independent variable and outcome, corrected for all other variables: * p<0.05, ** p<0.01, *** p<0.001.

Table S6: Results from the full logistic regression model evaluating the associations between family and home related factors and child's SSB intake in servings per day (≤2 vs >2) per ethnic background child

	Dutch (n=167)	Surinamese/ Antillean (n=111)	Moroccan/ Turkish (n=147)	Other/ unknown (n=91)
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Socio-demographic characteristics				
Gender child, boy=ref	**0.37 (0.14;0.97)***	1.20 (0.35;4.09)	**0.41 (0.18;0.94)***	1.17 (0.40;3.39)
Age child (in years)	1.20 (0.92;1.56)	1.34 (0.94;1.91)	**1.35 (1.06;1.73)***	1.37 (0.96;1.96)
Educational level of parent				
Low	**8.67 (1.37;54.79)***	5.83 (0.47;71.84)	0.98 (0.21;4.50)	0.99 (0.19;5.25)
Mid-low	0.46 (0.13;1.63)	5.36 (0.90;31.96)	0.63 (0.14;2.94)	1.43 (0.26;7.68)
Mid-high	3.09 (0.93;10.28)	**5.35 (1.22;23.42)***	0.80 (0.16;3.97)	1.76 (0.39;7.99)
High	- REF -	- REF -	- REF -	- REF -
Cognitive variables[1]				
Attitude	2.41 (0.78;7.51)	**0.13 (0.03;0.56)****	1.05 (0.50;2.23)	0.99 (0.34;2.90)
Attitude towards decreasing SSB	1.11 (0.55;2.26)	0.55 (0.23;1.29)	1.07 (0.56;2.05)	1.03 (0.49;2.16)
Subjective norm	1.85 (0.91;3.77)	1.26 (0.53;3.02)	**1.95 (1.20;3.16)****	1.25 (0.59;2.66)
Perceived behavioural control	0.82 (0.45;1.48)	1.24 (0.55;2.80)	0.79 (0.45;1.41)	0.80 (0.42;1.54)
Environmental variables[1]				
Availability	1.15 (0.74;1.79)	1.60 (0.84;3.03)	0.87 (0.62;1.22)	0.76 (0.43;1.34)
Parenting practices	1.72 (0.74;4.02)	2.78 (0.92;0.84)	**2.18 (1.00;4.75)***	0.90 (0.32;2.54)
Rules	0.76 (0.20;2.83)	0.97 (0.23;4.15)	1.12 (0.37;3.40)	**5.56 (1.43;21.69)***
Modelling	**2.1 (1.39;3.42)****	**2.67 (1.30;5.49)****	1.34 (0.87;2.08)	1.54 (0.91;2.62)
- Modelling *separate item*	1.33 (0.97;1.84)	0.73 (0.48;1.12)	0.78 (0.55;1.10)	1.09 (0.73;1.62)
Habit variables[1]				
Habit strength	**2.50 (1.31;4.77)****	1.61 (0.64;4.08)	0.68 (0.36;1.28)	2.38 (0.89;6.37)
Taste preference	0.69 (0.35;1.32)	0.95 (0.51;1.76)	1.17 (0.72;1.91)	0.80 (0.40;1.57)
Nagelkerke R^2 (adjusted)[2]	**.592**	**.495**	**.281**	**.356**

REF = reference category.
[1] Higher scores indicate expectation of more SSB consumption/higher score on unfavourable behaviour.
[2] Nagelkerke R square statistic represents the estimated level of variance explained by the regression model.
Note: results from the full model with all independent variables; numbers printed in **bold** represent significant association between independent variable and **≤2 vs >2 SSB intake in servings per day** of child in that model. Asterisks' represent the level of significance of the association between independent variable and outcome, corrected for all other variables: * p<0.05, ** p<0.01, *** p<0.001.

4

Associations between family and home-related factors and child's snack consumption, differences within ethnic groups explored

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Abstract

Background: Energy-dense snacks are considered unhealthy due to their high concentrations of fat and sugar and low concentrations of nutrients. The present study aimed to evaluate associations between family and home-related factors and children's snack consumption. We explored associations within subgroups based on ethnic background of the child.

Methods: Cross-sectional data from the population-based 'Water Campaign' study were used. Parents (n=644) of primary school children (6 to 13 years old) completed a questionnaire on socio-demographic characteristics, family and home-related factors and child's snack intake. The family and home-related factors under study were: cognitive variables (e.g., parental attitude, subjective norm), environmental variables (e.g., availability of SSB, parenting practices), and habitual variables (e.g., habit strength, taste preference). Logistic regression analyses were used to evaluate the associations between family and home-related factors and child's snack intake ($p<0.05$).

Results: Mean age of the children was 9.4 years (SD: 1.8) and 53.1% were girls. Of the children, 28.7% consumed more than one snack per day. Parents' subjective norm, parenting practices, and parental modelling were positively associated with the child's snack intake. The associations under study differed according to the child's ethnic background.

Conclusions: Our results provide support for interventions targeting children's snack consumption focussing on the identified family and home-related factors. Also, the relationships between these factors and the child's snack intake differed for children with distinct ethnic backgrounds. Therefore, we would recommend to tailor interventions taking into account the ethnic background of the family.

Background

Energy-dense snacks are considered unhealthy due to their high concentrations of fat and sugar and low concentrations of nutrients [1]. Also, more frequent consumption of snacks is associated with higher total energy intake, sugars accounting for a larger proportion of the total energy intake [2]. Eating of snacks is also related to overweight and other health problems later in life [3, 4]. It is known that dietary behaviour, healthy and unhealthy habits, may track from childhood into adulthood; therefore, childhood is a critical period for changes in health behaviour [5-7].

In the USA, national data on snack intake among children aged 2 to 9 years old showed an average intake of three energy-dense snacks per day [8]. This is comparable to the average intake in the Netherlands. The Dutch national food consumption survey showed that children have on average three energy-dense snack intakes per day [9]. Given the nature and extent of related health problems due to unhealthy dietary behaviours and childhood overweight, it is important to develop effective intervention programmes for families and children that include the promotion of a low snack intake as part of a balanced and healthy dietary pattern [10].

To increase the effectiveness of such interventions, it is necessary to identify the factors that are associated with unhealthy snack consumption [11-13]. In this study we apply the Environmental Research framework for weight Gain prevention (EnRG-framework) [14] to study factors that are associated with unhealthy snack consumption of school-aged children. According to the EnRG-framework, important for behaviour change are – in addition to socio-demographic characteristics and cognitive factors such as attitude and self-efficacy – factors related to the physical, social and home environment associated with child's snack intake [15-18]. Recent research especially emphasizes the role and influence of parents and the home environment in the development and establishment of children's healthy dietary behaviours. Therefore, parents may be important 'agents of change' with regard to the promotion of a healthy life style among children [19-21]. Additionally, it has been argued that habit strength and taste preferences are considered important factors that may affect the development of health behaviours in childhood [22, 23]. In our study we focus on parental attitudes, availability of snacks at home, parental

modelling and the child's own preferences and habits. In this study, we refer to these factors as "family and home-related factors".

Studies thus far have yielded mixed results with regard to the associations between family and home-related factors and the child's snack consumption [24-28]. This may be partly explained by the preliminary finding that associations between family and home-related factors and dietary behaviours such as children's snack intake may differ between subgroups with various ethnic backgrounds [29-31]. However, studies that specifically focus on evaluating whether the association between family and home-related factors and children's snack behaviour differ between subgroups are lacking [32-34]. According to Wyse and colleagues, the social-cultural environment (e.g., family eating patterns) may be amendable to intervene and is therefore relevant to be studied [35].

Therefore, insights into and understanding of the associations between family and home-related factors with child's health behaviour within different ethnic groups may contribute to the development of these interventions tailored to specific subgroups. In this study, our first objective is to assess the associations between family and home-related factors with children's snack intake, and the second objective is to explore these associations within different ethnic groups. We hypothesize that the home environment, especially parental attitudes and parental modelling, influence children's snack intake. Additionally, we hypothesize that the associations between family and home-related factors with children's snack intake are different within distinct ethnic groups.

Methods

Study population and procedure

Our cross-sectional study used data from the population-based 'Water Campaign' study, a controlled trial that assessed the effects of a combined school- and community-based intervention on children's SSB consumption [36]. The Medical and Ethical Review Committee of the Erasmus Medical Centre issued a 'declaration of no objection' (i.e., formal waver) for this study (reference number MEC-2011-183). Four primary schools located in multi-ethnic, disadvantaged neighbourhoods in Rotterdam, the Netherlands, were included in

the study. The included schools resulted from a convenience sample of schools participating in a municipal overweight intervention programme. Only schools in disadvantaged neighbourhoods were eligible for this intervention [36].

All children of grades 2 to 8 (aged 6 to 13 years old) within each of the four included schools were invited to participate, resulting in a total of 1288 invited children. Passive parental consent was obtained. Parents (and children) received a brochure with information to notify and inform them about the intervention and study participation. The study was also announced by the school, via the school letter and through the teachers and by flyers which were visible throughout the school. Parents (and children) were free to refuse participation without giving any explanation. They could do so by informing one of the teachers at their school or one of the researchers when present at school. At all times, the researchers could be contacted by a special phone-number or e-mail, for instance to decline participation [36].

For the present study, data from the baseline parental questionnaire was used. The questionnaire, administered March/April 2011) was mostly filled in by mothers (87.4%). The response rate of the baseline parental questionnaire of the Water Campaign study was 54.8% [36]. A study population of 644 children (6 to 13 years old) were available for this study. The data of 529 children/families (94.8%) were used for full analysis.

Measures

Socio-demographic characteristics child and parent

The child's gender (boy/girl), age (years), and ethnic background were assessed. Ethnic background was defined by country of birth of the parents according to definitions given by Statistics Netherlands [37]. The child's ethnic background was defined as Dutch if both parents had been born in the Netherlands; if one of the parents had been born in another country, ethnic background was defined according to that country; and if both parents had been born in different foreign countries, ethnic background was defined as the mother's country of birth. Ethnic background was categorized as 'Dutch'; 'Surinamese/Antillean'; 'Moroccan/Turkish'; or 'other/unknown'.

Respondents were either the father or the mother of the child, and parental gender was based on this item (male/female). From this point onwards, respondent is referred to as

'parent'. Parental age (years) and educational level were also reported. Based on standard Dutch cut-off points, parents' highest achieved educational level was categorized as 'low' (no education; primary school; ≤3 years of general secondary school); 'mid-low' (>3 years of general secondary school); 'mid-high' (higher vocational training; undergraduate programs); or 'high' (higher academic education) [38].

In addition to the parental questionnaire, weight and height of the child were obtained by trained personnel. Weight status was determined by calculating the child's Body Mass Index (BMI) in kg/m^2 with height measured to the nearest 0.1cm and weight measured to the nearest 0.2kg, in light clothing or gym clothes, according to a national standardized protocol for Youth Health Care [39]. Children were categorized as being either 'non-overweight' or 'overweight/obese', based on BMI cut-off points published by the International Obesity Task Force [40].

Family and home-related factors

Table S1 in Supplement 1 provides an overview of the scales (and items) that were used to measure the family and home-related factors: (a) cognitive variables, (b) environmental variables, and (c) habitual variables. These factors were assessed with items derived from previously used questionnaires in the studies 'ENDORSE' and 'Be Active, Eat Right' [41, 42]. They were developed using the Theory of Planned Behaviour (TPB) as proposed by Ajzen [43]. The items were tailored to the consumption of snacks by children as suggested by Oluka et al. [44] and by Francis et al. [45]. The items used to measure the construct 'habit' were derived from the Self-Report Behavioural Automaticity index [46, 47].

In Table S1 we report the percentages of missing answers per item and per scale as indicator of the feasibility of the measurements in our study. Scales were only computed when there were no missing data on any of the items. Table S1 also shows the Cronbach's alpha per scale to assess the internal consistency of each multi-item scale.

The cognitive variables assessed were parental attitude towards the child's snack consumption (two items, Cronbach's α=0.82), parental attitude towards decreasing the child's snack consumption (four items, Cronbach's α=0.67), parents' subjective norm towards the child's snack consumption (one item), and the perceived behavioural control of parents towards having their child eat less snacks (two items, Cronbach's α=0.77). The percentage of missing values ranges from 2.2% to 8.4%; the internal consistency measured

by Cronbach's alpha is ≥0.7 for one multi-item scales and >0.8 for two scales (all scales show 'good' internal consistency [48]).

Environmental variables assessed included the availability of snacks at home (one item) and the availability of snacks at school (one item), parenting practices towards the child's snack intake (four items, Cronbach's α=0.69), rules at home with regard to the child's snack intake (two items, Cronbach's α=0.78), and parental modelling (one single item 'modelling of snack consumption by partner of parent' and a two items-scale 'modelling of snack consumption by the parents', Cronbach's α=0.62). The percentage of missing values ranges 1.4% to 3.6%; the internal consistency measured by Cronbach's alpha is >0.7 for one of the multi-item scales and >0.8 for another multi-item scale (both are considered 'good'), and >0.6 for one scale (which is considered 'moderate'[48]).

Habitual variables assessed were habit strength of the child's snack intake (four items, Cronbach's α=0.8) and taste preference of the child towards snacks (one item). The percentage of missing values ranges from 1.6% to 4.7%; the internal consistency measured by Cronbach's alpha is >0.8 for the multi-item scale (which is considered 'good' [48]).

All items measuring the family and home-related factors were assessed by using a five-point response scale, except for the questions regarding restriction rules for the child's snack consumption (response scale 'yes'/'no'). All items were coded such that a higher score indicated a more 'unfavourable' behaviour/situation (i.e., the child was expected to consume more snacks). The internal consistency of the multi-item scales was overall 'moderate' to 'good' (Cronbach's α>0.60) [48, 49]. The relatively low number of missing values supports the feasibility of the measures. We recommend further research regarding the validity of these measurement instruments in diverse populations.

Snack consumption

The following definition of snacks was used: energy-dense snacks (snacks that are poor in nutrients and high in fat and/or sugar), which are consumed in between of the three main meals. Examples of snacks were provided, based on our definition of snacks.

Snack intake was assessed using the question 'On a day your child eats snacks, how many snacks does your child consume on average?'. Response categories ranged from 'none' to

'five or more'. This measure was dichotomised for analysing purposes into ≤1 and >1 snacks per day.

Statistical analysis

Analyses were conducted using SPSS version 22.0 (IBM Corp., Armonk, NY, USA). Data of 529 children/families (82%) were available for analysis. Child and parental characteristics were analysed using descriptive statistics. Logistic regression models were fitted, with the child's snack consumption as the dependent variable (≤1 vs >1 snacks per day). The family and home-related factors (cognitive, environmental and habitual variables) of snack consumption were used as independent variables in the model.

The independent variables were entered in the model as blocks, correcting for other variables within this block. All analyses were controlled for socio-demographic characteristics (child's age, gender and ethnic background, and parental educational level) as potential confounders in the associations between family and home-related factors and snack consumption. The first block that was entered in the model contained the cognitive variables (parental attitude, parents' subjective norm, and perceived behavioural control); the second block contained the environmental variables (availability, parenting practices, rules, and parental modelling); the third block contained the habitual variables (habit strength and child's taste preference). Finally, a full model was fitted with all independent variables. Odds ratio's with 95% confidence intervals (95% CI) were estimated. Results were considered significant at $p<0.05$[49].

To evaluate whether there were differences in the associations between family and home-related factors and child's snacking behaviour between the distinct ethnic subgroups children, an interaction term was added to the model. Separately per block of variables (cognitive, environmental, and habitual) an interaction between ethnic background and the variable of interest was analysed, the model being only corrected for the variables in that block and not for other socio-demographic variables except ethnic background (main effect). Several interactions differed statistically ($p<0.10$) [49]. Therefore, the previously described analyses were also applied separately for the subgroups of children with a Dutch, Surinamese/Antillean, Moroccan/Turkish, and other/unknown ethnic background.

Results

Study population characteristics

Mean age of the children was 9.4 years (SD: 1.8), 53.1% were girls and 32.3% were Dutch. According to the parents, the average snack intake of the children was 1.24 snacks per day (SD: 0.7) per day; 28.7% of the children consumed more than one snack per day (Table 1).

Table 1 shows the socio-demographic characteristics and children's snack intake for children of different ethnic backgrounds.

Associations related to the child's snack intake

Table 2 presents the results of the regression analyses evaluating the full model. Children of parents who have a more positive subjective norm towards their child's snack intake (p=0.024), having parents who express healthier parenting practices (i.e., more restrictive towards the child's snack consumption) (p=0.001), and who model healthy diet more often (scale p=0.001) were associated with lower snack intake of the child.

Table 1: Child and parental characteristics for the overall sample and according to ethnic background of the child (n=644)

	Overall sample (n=644) % or mean (SD)	Dutch (n=208) % or mean (SD)	Surinamese/ Antillean (n=137) % or mean (SD)	Moroccan/ Turkish (n=185) % or mean (SD)	Other/ unknown (n=114) % or mean (SD)	*P*-value[a]
CHILD characteristics						
Gender, % girl *missing, n=12*	53.1%	53.8%	50.9%	52.6%	55.3%	0.929
Age (in years), mean (SD) *missing, n=6*	9.4 (1.8)	8.7 (1.8)	9.4 (1.8)	9.6 (1.6)	10.3 (1.6)	**0.000**
Ethnic background						
% Dutch	32.3%					
% Surinamese/ Antillean	21.2%					
% Moroccan/ Turkish	28.7%					
% Other/ unknown	17.8%					
PARENTAL characteristic						
Educational level *missing, n=21*						**0.000**
% Low	20.2%	10.5%	7.1%	39.5%	22.3%	
% Mid-low	26.5%	32.7%	24.1%	27.0%	17.0%	
% Mid-high	33.8%	31.6%	46.4%	24.3%	38.3%	
% High	19.5%	25.1%	22.3%	9.2%	22.3%	
Snack intake child						
Average number of snacks per day, mean (SD) *missing, n=11*	1.24 (0.7)	1.26 (0.7)	1.16 (0.6)	1.23 (0.7)	1.32 (0.8)	0.398
Snacks per day, % >1 *missing, n=11*	28.7%	28.7%	23.2%	29.6%	34.0%	0.389

a = differences between groups stratified for outcome measures, tested with one-way Anova (continuous variables) and Chi-square test (categorical variables).
Note: numbers printed in **bold** represent significant differences between the ethnic backgrounds groups.

Table 2: Results from the linear regression models evaluating the associations between family and home-related factors and child's snack intake per day (≤1 vs >1) (n=529)

	Model 1	Model 2	Model 3	Model 4
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Cognitive variables[1]				
Parental attitude towards child's snack intake	**1.81 (1.31;2.50)*** **			1.15 (0.77;1.71)
Parental attitude towards decreasing child's snack intake	**0.71 (0.59;0.97)***			0.77 (0.57;1.05)
Parents subjective norm towards the child's snack intake	**1.91 (1.46;2.49)*** **			**1.41 (1.05;1.89)***
Perceived behavioural control of parents towards having their child eat less snacks	1.13 (0.87;1.46)			0.82 (0.61;1.11)
Environmental variables[1]				
Availability of snacks at school, brought from home		1.08 (0.90;1.29)		1.00 (0.82;1.22)
Availability of snacks at home		1.17 (0.97;1.41)		1.14 (0.92;1.42)
Parenting practices towards child's snack intake		**2.66 (1.76;4.03)*** **		**2.30 (1.43;3.71)****
Family and home rules with regard to child's snack intake		1.39 (0.79;2.45)		1.10 (0.59;2.02)
Parental modelling of snack intake		**1.67 (1.24;2.23)****		**(1.25;2.39)****
- Separate item 'Parental modelling by partner of parent'		1.01 (0.87;1.18)		1.10 (0.92;1.31)
Habitual variables[1]				
Habit strength of the child's snack intake			**1.98 (1.59;2.48)*** **	1.04 (0.75;1.45)
Taste preference of child towards snack			1.16 (0.94;1.45)	1.10 (0.85;1.43)
Nagelkerke R^2 (adjusted)[2]	**.147**	**.213**	**.127**	**.293**

REF = reference category.
[1] Higher scores indicate expectation of more snacks consumed/higher score on unfavourable behaviour.
[2] Nagelkerke R square statistic represents the estimated level of variance explained by the regression model.
Note: numbers printed in **bold** represent significant association between independent variable and **≤1 vs >1 snack intake per day** of child in that model. Asterisks' represent the level of significance of the association between independent variable and outcome, corrected for all other variables within the model and adjusted for all confounder (child's gender, age and ethnic background and educational level of the parent): * p<0.05, ** p<0.01, *** p<0.001.

Child's snack intake associations according to ethnic background of the child

Presented in Table 3 are the full models of the child's snack intake per day (≤1 vs >1) separately for the four subgroups based on ethnic background of the child.

The results are reported in accordance with STROBE (Strengthening the Reporting of Observational Studies in Epidemiology). See Supplement 2 for the STROBE checklist [50].

Table 3: Results from the full linear regression model evaluating the associations between family and home-related factors and child's snack intake per day (≤1 vs >1) according to the ethnic background of the child

	Dutch (n=171)	Surinamese/ Antillean (n=112)	Moroccan/ Turkish (n=152)	Other/unknown (n=94)
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Cognitive variables[1]				
Parental attitude towards child's snack intake	1.20 (0.43;3.38)	0.75 (0.24;2.31)	**2.62 (1.13;6.04)***	0.26 (0.06;1.12)
Parental attitude towards decreasing child's snack intake	**0.30 (0.14;0.64)****	**0.41 (0.17;0.97)***	1.41 (0.74;2.67)	1.38 (0.47;4.04)
Parents subjective norm towards the child's snack intake	0.86 (0.41;1.80)	1.34 (0.61;2.95)	**2.58 (1.38;4.83)****	1.02 (0.44;2.38)
Perceived behavioural control of parents towards having their child eat less snacks	0.57 (0.30;1.09)	1.25 (0.54;2.90)	0.96 (0.51;1.84)	1.01 (0.42;2.45)
Environmental variables[1]				
Availability of snacks at school, brought from home	0.90 (0.59;1.38)	1.15 (0.75;1.77)	1.03 (0.67;1.59)	1.03 (0.49;2.17)
Availability of snacks at home	1.43 (0.88;2.31)	0.96 (0.56;1.67)	1.14 (0.71;1.82)	1.22 (0.58;2.60)
Parenting practices towards child's snack intake	**4.26 (1.46;12.50)****	1.92 (0.50;7.40)	1.97 (0.80;4.84)	**7.51 (1.21;46.58)***
Family and home rules with regard to child's snack intake	3.64 (0.78;17.10)	1.03 (0.20;5.35)	1.31 (0.38;4.51)	0.32 (0.05;2.07)
Parental modelling of snack intake	**3.41 (1.63;7.11)****	0.68 (0.24;1.91)	**2.23 (1.05;4.72)***	2.35 (0.94;5.86)
- Separate item 'Parental modelling by partner of parent'	1.18 (0.83;1.69)	1.37 (0.88;2.12)	0.90 (0.58;1.39)	1.54 (0.85;2.81)
Habitual variables[1]				
Habit strength of the child's snack intake	1.15 (0.70;2.34)	1.36 (0.55;3.40)	0.84 (0.46;1.52)	1.14 (0.38;3.39)
Taste preference of child towards snack	1.35 (0.70;2.61)	0.89 (0.51;1.54)	0.81 (0.49;1.35)	2.55 (0.88;7.40)
Nagelkerke R^2 (adjusted)[2]	**.497**	**.397**	**.389**	**.568**

REF = reference category.
[1] Higher scores indicate expectation of more snacks consumed/higher score on unfavourable behaviour.
[2] Nagelkerke R square statistic represents the estimated level of variance explained by the regression model.
Note: numbers printed in **bold** represent significant association between independent variable and **≤1 vs >1 snack intake per day** of child in that model. Asterisks' represent the level of significance of the association between independent variable and outcome, corrected for all other variables within the model and adjusted for all confounder (child's gender, age and ethnic background and educational level of the parent): * p<0.05, ** p<0.01, *** p<0.001.

Discussion

In this paper, we assessed associations between family and home-related factors and children's snack intake. Overall, parents' subjective norm, parenting practices, and parental modelling showed to be associated with child's snack intake. Associations between family and home-related factors with child's snack intake differ for children with a Dutch, Surinamese/Antillean, Moroccan/Turkish, and other/unknown background.

Compared to the Dutch national food survey, parent reported snack consumption in our sample was relatively low (1.2 vs 3.3 snacks per day) [9]. The national food survey is based on a representative national sample, while this study concern a representative multi-ethnic inner-city population. We recommend future studies in varied populations to confirm or reject the current findings.

Our results on associations of family and home-related factors and children's snack intake confirm the results of previous studies; i.e., children of parents with a more 'favourable' subjective norm towards their child's snack intake, eat less snacks [24, 28]. Also, children of parents who express more 'favourable' parenting practices towards the child's snack intake (i.e., more restrictive towards the child's snack consumption) and children of parents who model snack consumption less often, are reported to have a lower snack intake [17, 24, 51, 52].

Contrary to other studies, we did not find any association between the reported availability of snacks in the home and the child's snack intake [1, 27, 52]. This could be due to the cross-sectional nature of our study; in families with children who already have high consumption levels, parents might make sure that less snacks are available. If so, this would suggest the presence of already implemented restrictions of the parents in order to improve the child's lifestyle. Another possible explanation may be that children in our sample live in inner-city neighbourhoods, where ample food shops and supermarkets are present; therefore the availability at home might be relatively less important.

The positive associations between parenting practices and parental modelling and the child's snack consumption support the hypothesis that parents may have an important role in shaping the child's dietary habits [17, 51, 53, 54]. To increase interventions' effectiveness,

intervention developers may include parents specifically as target of the intervention [19-21, 25, 51, 55].

This study provides some support for the hypothesis that the associations between home and family related factors and children's snack intake vary between subgroups of children with various ethnic backgrounds. Only few studies have investigated differences in factors associated with energy balance-related behaviours according to ethnic background [32, 34]. For instance, Brug and colleagues investigated differences between native and non-native children in several European countries with respect to their intake of sugar-sweetened beverages and breakfast skipping (among others). Comparable to our results, differences were found between ethnic groups with regard to associations of factors such as parental attitude and parenting practices and healthy nutrition behaviours of children [34].

Though our results showed some differences between the ethnic subgroups with regard to parental subjective norm, parenting practices, parental modelling, and parental attitude towards (decreasing) the child's snack intake, no clear patterns were recognizable. We recommend further quantitative studies to evaluate differences between ethnic subgroups in the population with regard to the factors of children's snacking behaviour, ideally with a larger sample size and a longitudinal design. In addition, we recommend qualitative research to increase the understanding of the relevance of factors that are important for healthy lifestyles of children in varied ethnic subgroups in the population.

Differences in associations between family and home-related factors and child's snacking behaviour per ethnic subgroups may have practical implications for developers of interventions. When the intervention population is diverse – e.g., ethnically or culturally diverse – there may be different factors relevant to be addressed in subgroups within the population. Health promotion professionals should be aware of different subgroups within a population and gain knowledge about these subgroups in order to be able to better target their intervention; a certain degree of tailoring of interventions to population subgroups may be beneficial [36, 56].

Interventions can be developed for broad populations including all different factors that seem relevant to achieve behaviour change in all subgroups [57]. Such generic factors might

be health education, skills training and role play in the intervention to change factors (respectively, parental attitude, parents' subjective norm and parental modelling) [58]. By incorporating relevant generic aspects in the intervention, all (ethnic) subgroups would benefit. An alternative approach can be to tailor interventions separate for specific subgroups [59-61]. Tailoring to all subgroups or alternatively a selection of subgroups is possible [62]. Specific tailoring to one subgroup and broad implementation (and participation) can be combined [63]. Though the intervention is available for everyone, one might expect to see more effective and sustainable behaviour change in the tailored subgroup compared to the other subgroups within the population [64, 65]. For example, in the 'Water Campaign' intervention, different subgroups were defined within the potential intervention population [36]. The 'Water Campaign' was developed by tailoring to the wishes and needs of the subgroup in which the developers thought that most health behaviour benefits could be achieved [66].

Methodological considerations

A strengths of our study is the ethnic diversity of the study population. The participation rate of parents can be considered as relatively high, given a study in a multi-ethnic, disadvantaged inner-city study area. In the parent questionnaire, a wide range of family and home-related factors was assessed.

A limitation is the cross-sectional design, which precludes causal interpretation of our findings. It is recommended to explore and test our findings for causal inferences in longitudinal or experimental studies. Also, the study was conducted in multi-ethnic inner-city neighbourhoods. The generalizability of our study findings might therefore be limited to children belonging to similar populations and settings. We relied on parental self-reports. Though there is a possibility that parents may have provided socially desirable answers; however, parent reports have shown to be an accurate method to estimate dietary intake in school-aged children [67]. The measurements of family and home-related factors were based on the TPB and tailored to the consumption of SSB by children, as suggested by Oluka et al. [44] and Francis et al. [45]. In our study, the Cronbach's alphas indicate 'moderate' to 'good' reliability of the multi-item scales. We recommend further

research regarding the validity of these measurement instruments in multi-ethnic populations.

In our study, we combined children of Surinamese and Antillean decent ('Caribbean'), and of Moroccan and Turkish decent ('Mediterranean') into a single subgroup, in order to avoid very small subgroups in the analyses. Still, in the study we had relatively small subgroups, which limited the power to detect significant associations within the subgroups.

Conclusions

The design of effective interventions to improve children's dietary behaviours is a challenge that can benefit from thorough preparatory research activities. This paper provided insight into factors related to children's snack consumption in a varied population. We observed that parents' subjective norm, parenting practices, and parental modelling were associated with the child's snack consumption. These findings provide support for interventions to focus on parents and improve their (family) lifestyle in order to promote healthy behaviours in children. We also observed some differences between ethnic subgroups with respect to the associations between family and home-related factors and child's snack consumption. Further quantitative and qualitative studies should address the differences between ethnic subgroups in the population with regard to the underlying factors of children's snack consumption, and whether it is beneficial to tailor interventions to promote healthy dietary behaviours to diverse subgroups in multi-ethnic populations.

References

1. van Ansem WJ, Schrijvers CT, Rodenburg G, van de Mheen D. Children's snack consumption: role of parents, peers and child snack-purchasing behaviour. Results from the INPACT study. *Eur J Public Health* 2015; **25**(6)**:** 1006-11.
2. Field AE, Austin SB, Gillman MW, Rosner B, Rockett HR, Colditz GA. Snack food intake does not predict weight change among children and adolescents. *Int J Obes Relat Metab Disord* 2004; **28**(10)**:** 1210-6.
3. Daniels SR. Complications of obesity in children and adolescents. *Int J Obes (Lond)* 2009; **33 Suppl 1:** S60-5.
4. Reilly JJ, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. *Int J Obes (Lond)* 2011; **35**(7)**:** 891-8.
5. Craigie AM, Lake AA, Kelly SA, Adamson AJ, Mathers JC. Tracking of obesity-related behaviours from childhood to adulthood: A systematic review. *Maturitas* 2011; **70**(3)**:** 266-84.
6. 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**(7)**:** 1121-6.
7. Patterson E, Warnberg J, Kearney J, Sjostrom M. The tracking of dietary intakes of children and adolescents in Sweden over six years: the European Youth Heart Study. *Int J Behav Nutr Phys Act* 2009; **6:** 91.
8. Piernas C, Popkin BM. Trends in snacking among U.S. children. *Health Aff (Millwood)* 2010; **29**(3)**:** 398-404.
9. Gevers DW, Kremers SP, de Vries NK, van Assema P. Intake of energy-dense snack foods and drinks among Dutch children aged 7-12 years: how many, how much, when, where and which? *Public Health Nutr* 2016; **19**(1)**:** 83-92.
10. Scholten EW, Schrijvers CT, Nederkoorn C, Kremers SP, Rodenburg G. Relationship between impulsivity, snack consumption and children's weight. *PLoS ONE* 2014; **9**(2)**:** e88851.
11. Baranowski T, Cullen KW, Nicklas T, Thompson D, Baranowski J. Are current health behavioral change models helpful in guiding prevention of weight gain efforts? *Obes Res* 2003; **11 Suppl:** 23S-43S.
12. Egger G, Swinburn B. An "ecological" approach to the obesity pandemic. *BMJ* 1997; **315**(7106)**:** 477-80.
13. Brug J, van Lenthe FJ, Kremers SP. Revisiting Kurt Lewin: how to gain insight into environmental correlates of obesogenic behaviors. *Am J Prev Med* 2006; **31**(6)**:** 525-9.
14. Kremers SP, de Bruijn GJ, Visscher TL, 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.

15. Dubois L, Farmer A, Girard M, Burnier D, Porcherie M. Demographic and socio-economic factors related to food intake and adherence to nutritional recommendations in a cohort of pre-school children. *Public Health Nutr* 2011; **14**(6)**:** 1096-104.

16. 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**(2)**:** 230-40.

17. van der Horst K, Oenema A, Ferreira I, Wendel-Vos W, Giskes K, van Lenthe F *et al.* A systematic review of environmental correlates of obesity-related dietary behaviors in youth. *Health Educ Res* 2007; **22**(2)**:** 203-26.

18. Haerens L, Craeynest M, Deforche B, Maes L, Cardon G, De Bourdeaudhuij I. The contribution of psychosocial and home environmental factors in explaining eating behaviours in adolescents. *Eur J Clin Nutr* 2008; **62**(1)**:** 51-9.

19. Golan M, Crow S. Parents are key players in the prevention and treatment of weight-related problems. *Nutr Rev* 2004; **62**(1)**:** 39-50.

20. Rosenkranz RR, Dzewaltowski DA. Model of the home food environment pertaining to childhood obesity. *Nutr Rev* 2008; **66**(3)**:** 123-40.

21. Conlon BA, McGinn AP, Lounsbury DW, Diamantis PM, Groisman-Perelstein AE, Wylie-Rosett J *et al.* The Role of Parenting Practices in the Home Environment among Underserved Youth. *Child Obes* 2015; **11**(4)**:** 394-405.

22. Birch LL. Development of food preferences. *Annu Rev Nutr* 1999; **19:** 41-62.

23. Nederkoorn C, Houben K, Hofmann W, Roefs A, Jansen A. Control yourself or just eat what you like? Weight gain over a year is predicted by an interactive effect of response inhibition and implicit preference for snack foods. *Health Psychol* 2010; **29**(4)**:** 389-93.

24. 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**(8)**:** 1380-95.

25. De Craemer M, De Decker E, De Bourdeaudhuij I, Vereecken C, Deforche B, Manios Y *et al.* Correlates of energy balance-related behaviours in preschool children: a systematic review. *Obes Rev* 2012; **13 Suppl 1:** 13-28.

26. Rodenburg G, Kremers SP, Oenema A, van de Mheen D. Psychological control by parents is associated with a higher child weight. *Int J Pediatr Obes* 2011; **6**(5-6)**:** 442-9.

27. Larson N, Story M. A review of snacking patterns among children and adolescents: what are the implications of snacking for weight status? *Child Obes* 2013; **9**(2)**:** 104-15.

28. Gubbels JS, Kremers SP, Stafleu A, de Vries SI, Goldbohm RA, Dagnelie PC *et al.* Association between parenting practices and children's dietary intake, activity behavior and development of body mass index: the KOALA Birth Cohort Study. *Int J Behav Nutr Phys Act* 2011; **8:** 18.

29. Varela RE, Vernberg EM, Sanchez-Sosa JJ, Riveros A, Mitchell M, Mashunkashey J. Parenting style of Mexican, Mexican American, and Caucasian-non-Hispanic families: social context and cultural influences. *J Fam Psychol* 2004; **18**(4)**:** 651-7.

30. Brug J, van Stralen MM, Chinapaw MJ, De Bourdeaudhuij I, Lien N, Bere E *et al.* 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; **7**(5)**:** 399-411.

31. te Velde SJ, Singh A, Chinapaw M, De Bourdeaudhuij I, Jan N, Kovacs E *et al.* Energy balance related behaviour: personal, home- and friend-related factors among schoolchildren in Europe studied in the ENERGY-project. *PLoS ONE* 2014; **9**(11)**:** e111775.

32. Chuang RJ, Sharma S, Skala K, Evans A. Ethnic differences in the home environment and physical activity behaviors among low-income, minority preschoolers in Texas. *Am J Health Promot* 2013; **27**(4)**:** 270-8.

33. Skala K, Chuang RJ, Evans A, Hedberg AM, Dave J, Sharma S. Ethnic differences in the home food environment and parental food practices among families of low-income Hispanic and African-American preschoolers. *J Immigr Minor Health* 2012; **14**(6)**:** 1014-22.

34. Brug J, Uijtdewilligen L, van Stralen MM, Singh AS, Chin AMJ, De Bourdeaudhuij I *et al.* Differences in beliefs and home environments regarding energy balance behaviors according to parental education and ethnicity among schoolchildren in Europe: the ENERGY cross sectional study. *BMC Public Health* 2014; **14:** 610.

35. Wyse R, Campbell E, Nathan N, Wolfenden L. Associations between characteristics of the home food environment and fruit and vegetable intake in preschool children: a cross-sectional study. *BMC Public Health* 2011; **11:** 938.

36. van de Gaar VM, Jansen W, van Grieken A, Borsboom G, Kremers S, Raat H. Effects of an intervention aimed at reducing the intake of sugar-sweetened beverages in primary school children: a controlled trial. *Int J Behav Nutr Phys Act* 2014; **11:** 98.

37. Swertz O, Duimelaar P, Thijssen J. *Statistics Netherlands. Migrants in the Netherlands 2004.* Statistics Netherlands: Voorburg/Heerlen, the Netherlands, 2004.

38. *Dutch Standard Classification of Education 2003*. Statistics Netherlands: Voorburg/Heerlen, Netherlands, 2004.

39. Bulk-Bunschoten AMW, Renders CM, Leerdam FJM, Hirasing RA. *Protocol for detection of overweight in preventive youth health care. [Signaleringsprotocol overgewicht in de jeugdgezondheidszorg]*. VUMC: Amsterdam, 2004.

40. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000; **320**(7244)**:** 1240-3.

41. 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.

42. Veldhuis L, Struijk MK, Kroeze W, Oenema A, Renders CM, Bulk-Bunschoten AM *et al.* 'Be active, eat right', evaluation of an overweight prevention protocol among 5-year-old children: design of a cluster randomised controlled trial. *BMC Public Health* 2009; **9:** 177.

43. Ajzen I. The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes* 1991; **50**(2)**:** 179-211.

44. Oluka OC, Nie S, Sun Y. Quality assessment of TPB-based questionnaires: a systematic review. *PLoS ONE* 2014; **9**(4)**:** e94419.

45. Francis J, Eccles MP, Johnston M, Walker AE, Grimshaw JM, Foy R *et al. Constructing questionnaires based on the theory of planned behaviour: A manual for health services researchers.* . Centre for Health Services Research, University of Newcastle: Newcastle, United Kingdom, 2004.

46. Gardner B, Abraham C, Lally P, de Bruijn GJ. Towards parsimony in habit measurement: testing the convergent and predictive validity of an automaticity subscale of the Self-Report Habit Index. *Int J Behav Nutr Phys Act* 2012; **9:** 102.

47. Verplanken B, Orbell S. Reflections on Past Behavior: A Self-Report Index of Habit Strength. *Journal of Applied Social Psychology* 2003; **33**(6)**:** 8.

48. de Vet HC, Terwee CB, Knol DL, Bouter LM. When to use agreement versus reliability measures. *J Clin Epidemiol* 2006; **59**(10)**:** 1033-9.

49. Field A. *Discovering Statistics Using SPSS*, vol. Second Edition. SAGE Publications: London, 2005.

50. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP *et al.* The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* 2007; **370**(9596)**:** 1453-7.

51. Bauer KW, Neumark-Sztainer D, Fulkerson JA, Hannan PJ, Story M. Familial correlates of adolescent girls' physical activity, television use, dietary intake, weight, and body composition. *Int J Behav Nutr Phys Act* 2011; **8:** 25.

52. Pearson N, Ball K, Crawford D. Predictors of changes in adolescents' consumption of fruits, vegetables and energy-dense snacks. *Br J Nutr* 2011; **105**(5)**:** 795-803.

53. 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**(2)**:** 202-11.

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. te Velde SJ, van Nassau F, Uijtdewilligen L, van Stralen MM, Cardon G, De Craemer M *et al.* Energy balance-related behaviours associated with overweight and obesity in preschool children: a systematic review of prospective studies. *Obes Rev* 2012; **13 Suppl 1:** 56-74.

56. 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.

57. Bartholomew LK, Parcel GS, Kok G, Gottlieb NH, Fernandez ME. *Planning health promotion programs, an intervention mapping approach*, 3rd edn Jossey-Bass: Francisco, California, 2011.

58. Bartholomew LK, Parcel GS, Kok G. Intervention mapping: a process for developing theory- and evidence-based health education programs. *Health Educ Behav* 1998; **25**(5)**:** 545-63.

59. Kreuter MW, Lukwago SN, Bucholtz RD, Clark EM, Sanders-Thompson V. Achieving cultural appropriateness in health promotion programs: targeted and tailored approaches. *Health Educ Behav* 2003; **30**(2)**:** 133-46.

60. Doak CM, Visscher TL, Renders CM, Seidell JC. The prevention of overweight and obesity in children and adolescents: a review of interventions and programmes. *Obes Rev* 2006; **7**(1)**:** 111-36.

61. Mauriello LM, Ciavatta MM, Paiva AL, Sherman KJ, Castle PH, Johnson JL *et al.* Results of a multi-media multiple behavior obesity prevention program for adolescents. *Prev Med* 2010; **51**(6)**:** 451-6.

62. Hawkins RP, Kreuter M, Resnicow K, Fishbein M, Dijkstra A. Understanding tailoring in communicating about health. *Health Educ Res* 2008; **23**(3)**:** 454-66.

63. French J, Blair-Stevens C, McVey D, Merritt R. *Social Marketing and Public Health – Theory and Practice*, Oxford University Press: Oxford, 2010.

64. Borys JM, Le Bodo Y, Jebb SA, Seidell JC, Summerbell C, Richard D *et al.* EPODE approach for childhood obesity prevention: methods, progress and international development. *Obes Rev* 2012; **13**(4)**:** 299-315.

65. Taylor NJ, Sahota P, Sargent J, Barber S, Loach J, Louch G *et al.* Using intervention mapping to develop a culturally appropriate intervention to prevent childhood obesity: the HAPPY (Healthy and Active Parenting Programme for Early Years) study. *Int J Behav Nutr Phys Act* 2013; **10:** 142.

66. Blanchette LMG, van de Gaar VM, Raat H, French J, Jansen W. The development of the "Water Campaign": Combining social marketing and intervention mapping. *Journal of Social Marketing* 2016; **6**(4)**:** 16.

67. Burrows TL, Martin RJ, Collins CE. A systematic review of the validity of dietary assessment methods in children when compared with the method of doubly labeled water. *J Am Diet Assoc* 2010; **110**(10)**:** 1501-10.

Supplements

Supplement 1. Table S1: Descriptive results and scale information for the family and home-related factors (n=644)

	General information		Scale information		(Example of) Questionnaire item
	n (%)	mean (SD)	# items	Cronbach's α (stand.)	
Cognitive variables[1]					
Parental attitude towards child's snack intake *(range 1-5)*	630 (97.8%)	2.7 (0.7)	2	0.8	e.g., "When my child eats snacks, I find it…" (pleasant – not so pleasant)
Parental attitude towards decreasing child's snack intake *(range 1-5)*	590 (91.6%)	2.4 (0.9)	4	0.7	e.g., "I believe my child should consume less snacks." (agree – disagree)
Parents subjective norm towards the child's snack intake *(range 1-5)*	629 (97.7%)	2.1 (0.8)	1	-	i.e., "When comparing your child with other children of his/her age, does your child consume more or less snacks?" (more – less)
Perceived behavioural control of parents towards having their child eat less snacks *(range 1-5)*	627 (97.4%)	2.1 (0.8)	2	0.8	e.g., "Does it seem difficult or easy to let your child eat less snacks?" (difficult – easy)
Environmental variables[1]					
Availability of snacks at school, brought from home *(range 1-5)*	635 (98.6%)	0.6 (1.1)	1	-	e.g., "Snacks - brought from home - are usually available for my child at school." (agree – disagree)
Availability of snacks at home *(range 1-5)*	632 (98.1%)	3.2 (1.3)	1	-	e.g., "Snacks are usually available for my child at home." (agree – disagree)
Parenting practices towards child's snack intake *(range 1-5)*	621 (96.4%)	2.4 (0.6)	4	0.7	e.g., "To what extent do you monitor how often your child eats snacks?" (never – always)
Rules at home with regard to child's snack intake *(range 1-2)*	623 (96.7%)	1.2 (0.4)	2	0.8	e.g., "Are there in your home rules about how many snacks your child may consume?" (yes – no)
Modelling of snack intake by the parents *(range 1-5)*	623 (96.7%)	2.1 (0.8)	2	0.6	e.g., "How often do you (or your partner) eat snacks together with your child? (never – every day, multiple times)
- Separate item 'Parental Modelling by partner of parent' *(range 1-5)*	603 (93.6%)	2.1 (1.4)	1	-	i.e., "Does your partner consume snacks often?" (never – always)

Table S1 (continued)

Habitual variables[1]					
Habit strength of the child's snack intake *(range 1-5)*	614 (95.3%)	2.4 (1.0)	4	0.8	e.g., "My child often eats snacks without thinking about it." (agree – disagree)
Taste preference of child towards snack *(range 1-5)*	634 (98.4%)	4.1 (1.0)	1	-	i.e., "My child likes the taste of snacks." (agree – disagree)

[1]Higher scores indicate the expectation of more SSB consumption/a higher score on unfavourable behaviour.

Supplement 2. STROBE 2007 (v4) Statement – Checklist of items that should be included in reports of *cross-sectional studies*

Section/ Topic	#	Recommendation	Reported on page #
Title and abstract			
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	90
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	90
Introduction			
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	91
Objectives	3	State specific objectives, including any prespecified hypotheses	91
Methods			
Study design	4	Present key elements of study design early in the paper	92
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	92
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	93-96
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	93-96
Bias	9	Describe any efforts to address potential sources of bias	na
Study size	10	Explain how the study size was arrived at	92
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	93-96
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	96
		(b) Describe any methods used to examine subgroups and interactions	96
		(c) Explain how missing data were addressed	94
		(d) If applicable, describe analytical methods taking account of sampling strategy	na
		(e) Describe any sensitivity analyses	na

Supplement 2 (continued)

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study – e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	97, Table 1
		(b) Give reasons for non-participation at each stage	na
		(c) Consider use of a flow diagram	Table 1
Descriptive data	14*	(a) Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders	97-97
		(b) Indicate number of participants with missing data for each variable of interest	Table 1
Outcome data	15*	Report numbers of outcome events or summary measures	97-100, Tables 1-3
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g.,, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	97-100, Tables 2-3
		(b) Report category boundaries when continuous variables were categorized	94-95
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	na
Other analyses	17	Report other analyses done – e.g., analyses of subgroups and interactions, and sensitivity analyses	100, Table 3
Discussion			
Key results	18	Summarise key results with reference to study objectives	102-105
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	104
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	102-105
Generalisability	21	Discuss the generalisability (external validity) of the study results	102-105
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	92

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

5

Feeding styles, parenting styles and snacking behaviour in school-aged children: findings from a multi-ethnic population

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Abstract

Background: The aim of the present study was to investigate whether feeding styles and parenting styles are associated with children's unhealthy snacking behaviour and whether the associations differ according to children's ethnic background.

Methods: Cross-sectional data from the population-based 'Water Campaign' study were used. Parents (n=644) of primary school children (6 to 13 years old) completed a questionnaire covering socio-demographic characteristics, feeding styles ('control over eating', 'emotional feeding', 'encouragement to eat' and 'instrumental feeding'), parenting styles ('involvement' and 'strictness'), and children's unhealthy snack intake. Logistic regression analyses were performed to determine whether feeding styles and parenting styles were associated with children's unhealthy snacking behaviour.

Results: Children whose parents had a higher extent of 'control over eating' had a lower odds of eating unhealthy snacks more than once per day (odds ratio (OR) 0.57, 95%CI 0.42;0.76). Further stratified analysis showed that 'control over eating' was associated with less unhealthy snack consumption only in children with a Dutch ethnic background (OR 0.37, 95%CI 0.20;0.68), or a Moroccan or Turkish ethnic background (OR 0.44, 95%CI 0.25;0.77). 'Encouragement to eat' was associated with a lower odds of eating unhealthy snacks every day in children with a Dutch ethnic background only (OR 0.48, 95%CI 0.25;0.90). 'Instrumental feeding' was associated with a higher odds of eating unhealthy snacks more than once a day in children with a Moroccan or Turkish ethnic background only (OR 1.43, 95%CI 1.01;2.04).

Conclusions: Our results suggest that 'control over eating' may be associated with less unhealthy snack consumption in children. The associations of feeding styles and parenting styles with children's unhealthy snacking behaviour differ between children with different ethnic background.

Background

A high intake of unhealthy snack foods – i.e., snack foods high in fat, sugar and salt but low in micronutrients – is known to have adverse health outcomes (e.g., overweight, metabolic syndrome and dental caries)[1-4]. Among children, the consumption of unhealthy snack foods has increased largely over the past four decades [5]. According to the Netherlands' national food consumption survey 2007-2010, children aged 7 to 12 years old ate an average of 3.3 energy-dense snack foods a day, with 90% of children consuming more energy from unhealthy snack foods than is recommended (837 to 1255 kJ per day)[6]. Given that snacking habits are established during childhood and often persist into adulthood [7], snacking of unhealthy foods should be discouraged at an early age.

Parents play an important role in shaping children's eating behaviours, through food provision [8], parental modelling [9], as well as through feeding styles and parenting styles [10]. Parental feeding styles, such as 'control over eating' (controlling the child's food intake)[11, 12], and 'encouragement to eat' (encouraging the child to eat a variety of foods)[12, 13], have been associated with a lower unhealthy snack intake. While 'instrumental feeding' (using food as a reward) and 'emotional feeding' (offering food to soothe the child's negative emotions) have been associated with a higher unhealthy snack intake among children [11-13]. Parenting style can be defined as a constellation of attitudes and beliefs towards the child that create an emotional climate in which parents' behaviours are expressed [14]. In general, authoritative parenting style characterized by high involvement and high strictness is associated with healthier dietary behaviours for the child [10, 15-17], including lower unhealthy snack intake [18].

To date, only limited researches have investigated the associations of feeding styles and parenting styles with children's unhealthy snacking behaviour, and the majority of them have focused on native European populations [11-13, 18]. According to previous research and the socio-ecological model of health behaviours, the adoption as well as the impact of parental feeding styles and parenting styles may differ by ethnic groups [19-25]. We therefore hypothesized that the associations of feeding styles and parenting styles with children's unhealthy snacking behaviour are different for children with different ethnic backgrounds. To our best knowledge, few studies have investigated whether feeding

styles and parenting styles have differential impact on children's unhealthy snacking behaviour between ethnic groups. With regard to the development of interventions in diverse populations, it is important to study the differential influence of feeding styles and parenting styles on children's unhealthy snack consumption in each ethnic subgroup separately.

Therefore, the aim of the present study was to determine whether feeding styles and parenting styles are associated with children's unhealthy snacking behaviour, and whether the associations differ according to the child's ethnic background.

Methods

Study population

Our cross-sectional study used data from the population-based 'Water Campaign' study [26]. This controlled trial assessed the effects of a combined school- and community-based intervention on children's sugar-sweetened beverages consumption. Four primary schools located in multi-ethnic neighbourhoods in Rotterdam, the Netherlands, were included in the study; two schools were included as intervention schools, two schools were included as control schools. Intervention and control schools were matched on number of pupils, socio-economic status and overweight prevalence. The Medical and Ethical Review Committee of the Erasmus Medical Centre issued a 'declaration of no objection' (i.e., formal waver) for this study (reference number MEC-2011-183) [26].

At the participating schools, all children in grades 2 to 8 (1288 children, aged 6 to 13 years old) were invited to participate. Parents (and children) were informed about the intervention and study participation and were free to refuse participation without giving any explanation. Measurements were performed at baseline and after one year, using questionnaires (child and parental) and observations at school. For the present study, data from the baseline parental questionnaire (administered March/April 2011) was used. A study population of 644 children was available for analyses.

Measures

Socio-demographic characteristics

The socio-demographic characteristics of the child were assessed using the parental questionnaire. The child's ethnic background was based on the country of birth of the parents, according to definitions given by Statistics Netherlands [27]. The child's ethnic background was Dutch only if both parents had been born in the Netherlands; if one of the parents had been born in another country, then the ethnic background of the child was defined according to that country. If both of the parents had been born in other countries, the ethnic background of the child was defined according to the mother's country of birth [27]. The ethnic background of the child was categorized as Dutch, Surinamese/Antillean, Moroccan/Turkish, or other/unknown [26].

Respondents were either the father or the mother of the child, and parental gender was based on this item (male/female). Parental age (years) and educational level were also reported. According to the standard Dutch cut-off points, the educational level of the responding parent(s) was categorized as 'low' (no education; primary school; ≤3 years of general secondary school); 'mid-low' (>3 years of general secondary school); 'mid-high' (higher vocational training; undergraduate programmes); or 'high' (higher academic education)[28].

Weight status of the child

The child's height and weight were measured in light clothing without shoes by trained personnel, according to the Youth Health Care protocol [29]. The child's Body Mass Index (BMI) was calculated as kg/m^2. Children's weight status were categorized as being 'non-overweight', 'overweight' or 'obese' based on BMI cut-off points published by the International Obesity Task Force [30].

Feeding style

The validated Dutch version of the Parental Feeding Style Questionnaire (PFSQ)[31] was used to assess the four feeding style dimensions: 'control over eating' (10 items), 'emotional feeding' (4 items), 'instrumental feeding' (5 items) and 'encouragement to eat' (8 items). Parents were asked to respond on a five-point Likert scale ranging from 'never' (1 point) to 'always' (5 points). Average scores on each scale were calculated when less than half of the items in that scale were missing. For each dimension, less than 2% of the

scores were missing (Table 2). A higher score indicated a greater tendency for parents to apply a specific feeding style. In the present study, the Cronbach's α was 0.78 for the 'control over eating' scale, 0.87 for 'emotional feeding', 0.79 for 'instrumental feeding' and 0.77 for the 'encouragement to eat' scale.

Parenting style

The validated Dutch version of the Steinberg parenting style instrument [32-34] was used to measure the two parenting style dimensions: 'involvement' and 'strictness'. The 'involvement' scale contained nine items that assess indicators of parental loving, responsiveness, and involvement. The 'strictness' scale contained six items that asses parental monitoring and supervision of the child. Parents were asked to respond to each item on a five-point Likert scale ranging from 'strongly disagree' (1 point) to 'strongly agree' (5 points). Average scores on each scale were calculated when less than half of the items in that scale were missing. For each dimension, less than 2% of the scores were missing (Table 2). Based on the median split of both scales [33], four parenting style categories were further defined: 'authoritative' (high involvement and high strictness), 'authoritarian' (low involvement and high strictness), 'indulgent' (high involvement and low strictness), and 'neglectful' (low involvement and low strictness).

Snacking behaviour of the child

Two items in the parental questionnaire were used to assess the unhealthy snacking behaviour of the children. In the present study, unhealthy snacks were defined as energy-dense nutrient-poor foods eaten between the three main meals. Parents were provided with the following examples of unhealthy snacks: crisps, nuts, chocolate, mars bars, pastry, iced cake, ice cream, pizza, meatballs, and burgers. The first question asked the parents to indicate how many days in a normal week the child ate unhealthy snacks (answer categories: 'every day' and 'not every day'). The parents were also asked to report the frequency of eating unhealthy snacks for the child on such a day. The response categories ranged from 'none', '1 per day' to '5 or more per day', which were dichotomized into '≤1 snack per day' and '>1 snack per day' in the statistical analysis.

Statistical analysis

Descriptive statistics were used to present the demographic characteristics of the children and the responding parents. Differences in demographic characteristics between subgroups according to the child's ethnic background were compared using ANOVA or Kruskal-Wallis test for continuous variables and Chi-square test for categorical variables.

Logistic regression analyses were used to investigate whether feeding styles and parenting styles were associated with the child's unhealthy snacking behaviour. Unhealthy snacking behaviour of the child was assessed using two variables: eating unhealthy snack every day (yes/no), and snacking frequency per day (≤1 or >1 per day). Separate logistic regression models were built for each dimension of feeding style and parenting style, adjusted for potential confounders. In order to select potential confounders, we used logistic regression to examine the associations of the child's unhealthy snacking behaviour, and general linear regression to examine the associations of feeding styles and parenting styles. Factors were considered potential confounders if they were associated with both the child's unhealthy snacking behaviour and any of the dimensions of feeding styles and parenting styles.

To examine whether the associations between feeding styles, parenting styles and the child's unhealthy snacking behaviour differed according to the child's ethnic background, an interaction term of the independent variable with the child's ethnic background was added to the models. The interaction term was considered significant at a level of $p<0.10$ [35]. In Table 3, the significant interaction terms are shown, 3 out of 12 interaction terms were significant ($p<0.10$). The previous logistic regression models were then repeated for subgroups of children with a Dutch, Surinamese/Antillean, Moroccan/Turkish, and other/unknown ethnic background respectively. Assuming a random missing pattern of our data, complete–subject analyses were chosen to handle the missing values [36]. All analyses were conducted using the statistical software SAS (version 9.3, SAS Institute Inc, Cary, NC, 2010).

Results

Characteristics of the study population

The characteristics of the children and parents are shown in Table 1, which presents data from the overall sample as well as for each ethnic background subgroup. The mean age of the children in our study was 9.4 years (SD 1.8); 45.9% of them were boys and 30.3% had a Dutch ethnic background. Based on the parents' report, 14.6% of the children ate unhealthy snacks on a daily basis, and 29.7% ate unhealthy snacks more than once a day. The mean age of the responding parents was 37.9 years (SD 7.4), 87.4% of them were mothers, and 18.5% indicated having completed a high level of education.

Table 1: Characteristics of children and parents in the overall sample and according to the ethnic background of the child (n=644)

	Overall sample (n=644)	Dutch (n=195)	Surinamese/ Antillean (n=142)	Moroccan/ Turkish (n=186)	Other/ unknown (n=121)	*P*-value*
Child characteristics						
Age, mean (SD) *missing, n=6*	9.4 (1.8)	8.7 (1.8)	9.4 (1.8)	9.6 (1.5)	10.4 (1.6)	**<0.001**
Genderl, n (%) girl *missing n=12*	342 (54.1)	107 (55.2)	76 (53.9)	89 (50.0)	70 (58.8)	0.500
Overweight or obese†, n (%) *missing n=45*	138 (23.0)	25 (13.8)	35 (26.1)	54 (31.8)	24 (21.1)	**0.002**
Unhealthy snacks every day, n (%) yes *missing n=12*	92 (14.6)	32 (16.8)	20 (14.2)	21 (11.4)	19 (16.2)	0.450
Unhealthy snacks per day, n (%) >1 *missing n=17*	186 (29.7)	55 (28.8)	37 (26.1)	56 (30.4)	38 (32.8)	0.370
Parental characteristics						
Gender, Female, n (%) *missing n=47*	522 (87.4)	166 (88.8)	127 (94.8)	140 (82.4)	89 (84.0)	**0.007**
Age, mean (SD) *missing, n=6*	37.0 (8.9)	37.3 (8.6)	36.7 (7.7)	36.4 (9.4)	37.6 (10.0)	0.660
Education level of the parent *missing n=21*						**<0.001**
% Low	137 (22.0)	20 (10.6)	16 (11.4)	75 (41.2)	26 (23.2)	
% Mid-low	156 (25.0)	58 (30.7)	33 (23.6)	46 (25.3)	19 (17.0)	
% Mid-high	215 (34.5)	61 (32.3)	66 (47.1)	45 (24.7)	43 (38.4)	
% High	115 (18.5)	50 (26.5)	25 (17.9)	16 (8.8)	24 (21.4)	

***** *p*-value derived from Chi-square test (categorical variables) or ANOVA (continuous variables).
† Weight status of the child was categorized according to the BMI cut-off points published by the International Obesity Task Force.
Note: numbers printed in **bold** represent a significant association at $p<0.05$ between the independent variable and daily snack consumption.

Over all, the scores for all the feeding style dimensions and parenting style dimensions were different between the ethnic subgroups ($p<0.05$) (Table 2). Parents of children with a Dutch ethnic background reported using the highest levels of 'control over eating', and

'encouragement to eat', but the lowest levels of 'instrumental feeding' and 'emotional feeding' (post hoc analysis, $p<0.05$). Parents of children with a Surinamese or Antillean ethnic background had similar levels of 'encouragement to eat', 'instrumental feeding', and 'emotional feeding' with parents of children with a Dutch ethnic background, but a lower level of 'control over eating' (post hoc analysis, $p<0.05$). While parents of children with a Moroccan or Turkish ethnic background reported using the highest levels of 'instrumental feeding' and 'emotional feeding' (post hoc analysis, $p<0.05$).

Table 2: Average scores on feeding style dimensions and parenting style dimensions according to children's ethnic background (n=644)

	Dutch (n=195)		Surinamese/ Antillean (n=142)		Moroccan/ Turkish (n=186)		Other/ unknown (n=121)		*P*-value*
	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)	
Feeding style dimensions									
Control over eating	192	4.03 (0.55)	142	3.72 (0.63)	183	3.76 (0.58)	116	3.56 (0.72)	**<0.001**
Emotional feeding	191	1.58 (0.66)	142	1.58 (0.60)	184	2.02 (0.87)	116	2.03 (0.94)	**<0.001**
Encouragement to eat	192	3.86 (0.62)	141	3.80 (0.69)	184	3.74 (0.66)	116	3.72 (0.67)	**0.030**
Instrumental feeding	191	1.93 (0.78)	142	1.90 (0.77)	183	2.56 (0.91)	116	2.28 (0.93)	**<0.001**
Parenting style dimensions									
Involvement	190	4.58 (0.33)	142	4.65 (0.36)	180	4.55 (0.42)	115	4.48 (0.51)	**0.020**
Strictness	186	4.58 (0.58)	139	4.52 (0.63)	180	4.50 (0.57)	115	4.41 (0.71)	**0.030**

*The difference in the level of scores on each feeding style and parenting style dimension between ethnic groups, was compared using Kruskal-Wallis test.
Note: numbers printed in **bold** represent a significant association at $p<0.05$ between the independent variable and daily snack consumption.

Associations between feeding styles, parenting styles and snacking behaviour of children

Table 3 presents the associations between feeding styles, parenting styles and parent-reported unhealthy snacking behaviour of the child. With regard to feeding styles, children whose parents with a higher score on 'control over eating' had a lower odds of eating unhealthy snacks every day (OR 0.63, 95%CI 0.44;0.91), and of eating unhealthy

snacks more than once per day (OR 0.57, 95%CI 0.42;0.76). With regard to parenting styles, no significant association was observed for neither the 'involvement' nor the 'strictness' dimension with children's unhealthy snacking behaviour in the overall population. Children of parents with an 'indulgent' parenting style were less likely to eat unhealthy snacks every day (OR 0.25, 95%CI 0.09;0.73), compared to children with 'authoritative' parents.

Table 3: Results of the logistic regression analyses for the associations of the feeding styles and parenting styles with children's unhealthy snacking behaviour (n=644)

	Eating unhealthy snacks every day (Yes vs No)		Unhealthy Snacks frequency per day (>1 vs ≤1)	
Variables	**Unadjusted ***	**Adjusted †**	**Unadjusted ***	**Adjusted †**
	OR (95%CI)	**OR (95%CI)**	**OR (95%CI)**	**OR (95%CI)**
Feeding style dimensions				
Control over eating	**0.63 (0.45, 0.88)**	**0.63 (0.44, 0.91)**	**0.54 (0.41, 0.71)**	**0.57 (0.42, 0.76)**
Emotional feeding	0.92 (0.69, 1.23)	0.95 (0.69, 1.30)	**1.24 (1.01, 1.53)**	1.18 (0.93, 1.48)
Encouragement to eat	0.80 (0.57, 1.11)	0.73 (0.52, 1.04)	0.87 (0.67, 1.13)	0.97 (0.73, 1.28)
Instrumental feeding	0.92 (0.71, 1.19)	0.92 (0.69, 1.22)	1.10 (0.90, 1.33)	0.99 (0.80, 1.23)
Parenting style dimensions				
Involvement	**0.56 (0.33, 0.93)**	0.60 (0.35, 1.04)	0.68 (0.45, 1.04)	0.78 (0.50, 1.21)
Strictness	1.23 (0.83, 1.82)	1.43 (0.92, 2.21)	0.80 (0.61, 1.05)	0.89 (0.66, 1.20)
Parenting style categories				
Authoritative	- REF -	- REF -	- REF -	- REF -
Authoritarian	1.14 (0.57, 2.27)	1.10 (0.53, 2.28)	1.20 (0.68, 2.11)	1.31 (0.72, 2.38)
Indulgent	**0.26 (0.09, 0.76)**	**0.25 (0.09, 0.73)**	0.90 (0.51, 1.60)	0.87 (0.48, 1.56)
Neglectful	0.94 (0.57, 1.57)	0.84 (0.48, 1.46)	1.33 (0.89, 1.98)	1.21 (0.78, 1.87)

***** Results from separate logistic regression models for each independent variable, without adjusting for potential confounders.
† Results from separate logistic regression models for each independent variable, adjusted for the child's age, weight status, ethnic background, and the responding parent's education level.
Note: numbers printed in **bold** represent a significant association at $p<0.05$ between the independent variable and daily snack consumption.

Analyses according to ethnic background of the child

Table 4 shows the associations of feeding styles and parenting styles with children's unhealthy snacking behaviour according to ethnic background of the children. With regard to feeding styles, a higher score on the 'control over eating' was associated with a lower possibility of eating unhealthy snacks every day in children with a Dutch ethnic background (OR 0.41, 95%CI 0.21;0.79) and in children with a Moroccan or Turkish ethnic background (OR 0.40, 95%CI 0.19;0.88). A higher score on the 'encouragement' was also associated with lower possibility of eating unhealthy snacks every day in children with Dutch ethnic background only (OR 0.48, 95%CI 0.25;0.90). In addition, a higher score on the 'control over eating' was associated with a lower possibility of eating unhealthy snacks more than once per day in children with a Dutch ethnic background (OR 0.37, 95%CI 0.20;0.68) and in children with a Moroccan or Turkish ethnic background (OR 0.44, 95%CI 0.25;0.77). Finally, 'instrumental feeding' was associated with a higher possibility of eating unhealthy snacks more than once per day in children with a Moroccan or Turkish ethnic background only (OR 1.43, 95%CI 1.01;2.04).

With regard to parenting styles, a higher score on parental 'involvement' was associated with a lower possibility of eating unhealthy snacks every day in children with an 'other' ethnic background (OR 0.21, 95%CI 0.08;0.59). Children with an 'other' ethnic background whose parents have a 'neglectful' parenting style were more likely to eat unhealthy more than once a day (OR 2.78, 95%CI 1.05;7.33) compared to children with 'authoritative' parents.

The results are reported in accordance with STROBE (Strengthening the Reporting of Observational Studies in Epidemiology). See Supplement 2 for the STROBE checklist [37].

Table 4: Results of the logistic regression analyses for the associations of feeding styles and parenting styles with children's unhealthy snacking behaviour, stratified by child ethnic background

	Dutch n=195	Surinamese/ Antillean n=142	Moroccan/Turkish n=186	Other/unknown n=121
	OR (95%CI) †	OR (95%CI) †	OR (95%CI) †	OR (95%CI) †
Eating unhealthy snacks every day				
Feeding style dimensions				
Control over eating	**0.41 (0.21, 0.79)**	1.17 (0.52, 2.64)	**0.40 (0.19, 0.88)**	0.66 (0.33, 1.31)
Emotional feeding	1.13 (0.64, 2.00)	0.50 (0.18, 1.35)	1.01 (0.60, 1.71)	0.93 (0.53, 1.61)
Encouragement to eat	**0.48 (0.25, 0.90)**	1.17 (0.56, 2.47)	1.05 (0.52, 2.11)	0.71 (0.35, 1.45)
Instrumental feeding	1.10 (0.68, 1.80)	0.79 (0.40, 1.56)	1.13 (0.69, 1.85)	0.71 (0.40, 1.28)
Parenting style dimensions				
Involvement*	1.00 (0.32, 3.17)	1.74 (0.39, 7.86)	0.51 (0.18, 1.41)	**0.25 (0.09, 0.67)**
Strictness*	2.04 (0.86, 4.85)	2.60 (0.84, 8.09)	0.92 (0.41, 2.06)	0.67 (0.35, 1.29)
*Parenting style categories**				
Authoritative	- REF -	- REF -	- REF -	- REF -
Authoritarian	1.25 (0.48, 3.22)	0.58 (0.07, 5.16)	1.77 (0.31, 10.09)	0.49 (0.05, 4.54)
Indulgent	-‡	0.20 (0.03, 1.66)	1.55 (0.34, 6.99)	-‡
Neglectful	0.53 (0.20, 1.40)	0.31 (0.08, 1.18)	2.01 (0.68, 6.51)	2.33 (0.74, 7.33)
Unhealthy snacks >1 times per day				
Feeding style dimensions				
Control over eating	**0.37 (0.20, 0.68)**	1.02 (0.56, 1.85)	**0.44 (0.25, 0.77)**	**0.44 (0.24, 0.79)**
Emotional feeding	1.18 (0.74, 1.89)	0.84 (0.44, 1.59)	1.29 (0.93, 1.70)	**1.56 (1.02, 2.39)**
Encouragement to eat	0.64 (0.38, 1.02)	0.97 (0.56, 1.67)	1.20 (0.73, 1.96)	0.74 (0.41, 1.32)
Instrumental feeding	1.10 (0.74, 1.64)	0.84 (0.51, 1.38)	**1.43 (1.01, 2.04)**	0.80 (0.52, 1.25)
Parenting style dimensions				
Involvement*	1.26 (0.48, 3.29)	0.88 (0.31, 2.49)	0.65 (0.31, 1.37)	0.45 (0.20, 1.02)
Strictness*	1.13 (0.64, 2.00)	0.77 (0.43, 1.38)	0.83 (0.48, 1.44)	0.58 (0.33, 1.00)
*Parenting style categories**				
Authoritative	- REF -	- REF -	- REF -	- REF -
Authoritarian	1.79 (0.77, 4.14)	-‡	1.15 (0.35, 3.75)	0.94 (0.21, 4.14)
Indulgent	0.97 (0.35, 2.68)	0.83 (0.27, 2.61)	0.46 (0.14, 1.51)	2.68 (0.67, 10.73)
Neglectful	0.64 (0.28, 1.48)	1.03 (0.44, 2.44)	1.62 (0.79, 3.33)	**2.78 (1.05, 7.33**)

*Interaction term between ethnic background of the child and the noted independent variable was significant ($p<0.10$)

† Results from separate logistic regression model adjusted for the child's age and weight status, and the parent's education level.

‡ Not available due to low sample size in these groups (see Supplement 1 Table S1.)

Note: numbers printed in **bold** represent a significant association between the independent variable and unhealthy snacking behaviour of the child.

Discussion

In this study, we investigated the associations of feeding styles and parenting styles with unhealthy snack consumption in school-aged children from a multi-ethnic population. Our results suggest that 'control over eating' was associated with lower unhealthy snack consumption of the child, and that the associations of feeding styles and parenting styles with children's unhealthy snack consumption differed according to the ethnic background of the child.

In line with previous studies, the present study found that children whose parents had a higher level of 'control over eating' had a lower unhealthy snack consumption [11-13]. Further stratified analysis showed that 'control over eating' was associated with lower unhealthy snack consumption in most of the ethnic subgroups, except for the group of children with a Surinamese or Antillean ethnic background. Our results are in line with previous studies and suggest that parental control may play an important role to facilitate healthy snacking behaviour of children. The lack of association in the Surinamese or Antillean population might be due to the relatively lower level of 'control over eating', and a more traditional dietary pattern which contains lower unhealthy snack consumption in this population [38].

In the present study, 'encouragement to eat' was associated with a lower unhealthy snack consumption only in the group of children with a Dutch ethnic background. It is possible that the association between 'encouragement to eat' and lower unhealthy snack consumption only exists when parents provide the child with healthier alternatives instead of unhealthy snack foods. Further studies examining the association between parental 'encouragement to eat' and children's unhealthy snack consumption should consider the potential influence of food provision.

Previous research suggested that 'emotional feeding' and 'instrumental feeding' were positively associated with children's unhealthy snack intake [11-13]. While in our study, the associations of 'instrumental feeding' and 'emotional feeding' with children's unhealthy snack intake only existed in children with a Moroccan or Turkish ethnic background and in children with an 'other' ethnic background. In addition, our study suggests that parents of children with a Moroccan or Turkish ethnic background were more likely to apply 'instrumental feeding' and 'emotional feeding'. It has been indicated that parents mainly

offer unhealthy snack foods in the context of emotional and instrumental feeding practices [39]. Moreover, using snacks as a reward may increase children's preference for the rewarding snack [40]. Higher exposure together with increased preference for the unhealthy snack foods may contribute to an increased risk of high unhealthy snack intake among children. Therefore, further interventions should discourage the use of 'instrumental feeding' and 'emotional feeding' in parents of children with a Moroccan or Turkish ethnic background.

Although previous studies suggested that an 'authoritative' parenting style was associated with lower unhealthy snack consumption of children, we found no association between parenting styles and children's unhealthy snack consumption in most of the ethnic subgroups. The lack of association in most of the ethnic subgroups might be due to the low variability on the scores of both the 'involvement' and the 'strictness' dimension among parents. In the group of children with an 'other' ethnic background, a 'neglectful' parenting style was associated with a higher unhealthy snack consumption. The result in the group of children with an 'other' ethnic background is consistent with previous research [16, 18].

Our study suggests that the associations of feeding styles and parenting styles with child unhealthy snack consumption differed according to the ethnic background of the child. Differences in parental beliefs, knowledge and practices (e.g., modelling, food provision) between ethnic subgroups may contribute to the differential associations in the present study [19, 21]. We recommend conducting further qualitative and quantitative studies to gain more insight in ethnic subgroup differences for associations between feeding styles and parenting styles and children's snacking behaviour. Increased understanding may be helpful in developing tailored interventions for reducing unhealthy snack consumption in different ethnic subgroups.

Strengths and limitations

The main strengths of our study include the ethnically diverse study population, which enabled us to analyse the moderation effect of ethnicity on the associations of feeding styles and parenting styles with children's unhealthy snacking behaviours, and the use of validated questionnaires, which allowed comparisons with other studies. Several

limitations of this study should be noted. Firstly, as we relied on parents' self-reports for the child's snack consumption, social desirability and recall bias could have been possible. Parental reports have shown to be an accurate method to estimate dietary intake in school-aged children [41]. However, further studies may include a combination of parental report, child report and observational measures to estimate the child's snacking behaviour. Secondly, given the observational nature of cross-sectional design, this study does not allow firm conclusions regarding causality.

Conclusions

Our results suggest that 'control over eating' may be associated with less unhealthy snack consumption in children. The associations of feeding styles and parenting styles with children's unhealthy snacking behaviour differ between children with different ethnic backgrounds. However, due to the limitations of cross-sectional design, future longitudinal studies with larger sample sizes are recommended. In the meantime, to improve the effectiveness of interventions focusing on parenting behaviours to reduce unhealthy snacking of children, developers should take into account the potential role of children's ethnic background.

References

1. Bellisle F. Meals and snacking, diet quality and energy balance. *Physiol Behav* 2014; **134:** 38-43.
2. Mirmiran P, Bahadoran Z, Delshad H, Azizi F. Effects of energy-dense nutrient-poor snacks on the incidence of metabolic syndrome: a prospective approach in Tehran Lipid and Glucose Study. *Nutrition* 2014; **30**(5)**:** 538-43.
3. Who J, Consultation FAOE. Diet, nutrition and the prevention of chronic diseases. *World Health Organ Tech Rep Ser* 2003; **916**(i-viii).
4. Chapelot D. The role of snacking in energy balance: a biobehavioral approach. *J Nutr* 2011; **141**(1)**:** 158-62.
5. Larson N, Story M. A review of snacking patterns among children and adolescents: what are the implications of snacking for weight status? *Child Obes* 2013; **9**(2)**:** 104-15.
6. Gevers DW, Kremers SP, de Vries NK, van Assema P. Intake of energy-dense snack foods and drinks among Dutch children aged 7-12 years: how many, how much, when, where and which? *Public Health Nutr* 2015**:** 1-10.
7. Craigie AM, Lake AA, Kelly SA, Adamson AJ, Mathers JC. Tracking of obesity-related behaviours from childhood to adulthood: A systematic review. *Maturitas* 2011; **70**(3)**:** 266-84.
8. Cullen KW, Baranowski T, Owens E, Marsh T, Rittenberry L, de Moor C. Availability, accessibility, and preferences for fruit, 100% fruit juice, and vegetables influence children's dietary behavior. *Health Educ Behav* 2003; **30**(5)**:** 615-26.
9. Brown R, Ogden J. Children's eating attitudes and behaviour: a study of the modelling and control theories of parental influence. *Health Educ Res* 2004; **19**(3)**:** 261-71.
10. Vollmer RL, Mobley AR. Parenting styles, feeding styles, and their influence on child obesogenic behaviors and body weight. A review. *Appetite* 2013; **71:** 232-241.
11. Lo K, Cheung C, Lee A, Tam WW, Keung V. Associations between Parental Feeding Styles and Childhood Eating Habits: A Survey of Hong Kong Pre-School Children. *PLoS ONE* 2015; **10**(4)**:** e0124753.
12. Rodenburg G, Kremers SP, Oenema A, van de Mheen D. Associations of parental feeding styles with child snacking behaviour and weight in the context of general parenting. *Public Health Nutr* 2014; **17**(5)**:** 960-9.
13. Sleddens EF, Kremers SP, De Vries NK, Thijs C. Relationship between parental feeding styles and eating behaviours of Dutch children aged 6-7. *Appetite* 2010; **54**(1)**:** 30-6.
14. Darling N, Steinberg L. Parenting style as context: An integrative model. *Psychological Bulletin* 1993; **113**(3)**:** 487.
15. Sleddens EF, Gerards SM, Thijs C, de Vries NK, Kremers SP. General parenting, childhood overweight and obesity-inducing behaviors: a review. *Int J Pediatr Obes* 2011; **6**(2-2)**:** e12-27.
16. Pearson N, Atkin AJ, Biddle SJ, Gorely T, Edwardson C. Parenting styles, family structure and adolescent dietary behaviour. *Public Health Nutr* 2010; **13**(8)**:** 1245-53.

17. Blissett J. Relationships between parenting style, feeding style and feeding practices and fruit and vegetable consumption in early childhood. *Appetite* 2011; **57**(3)**:** 826-31.

18. Boots SB, Tiggemann M, Corsini N, Mattiske J. Managing young children's snack food intake. The role of parenting style and feeding strategies. *Appetite* 2015; **92:** 94-101.

19. Sherry B, McDivitt J, Birch LL, Cook FH, Sanders S, Prish JL *et al.* Attitudes, practices, and concerns about child feeding and child weight status among socioeconomically diverse white, Hispanic, and African-American mothers. *J Am Diet Assoc* 2004; **104**(2)**:** 215-21.

20. Blissett J, Bennett C. Cultural differences in parental feeding practices and children's eating behaviours and their relationships with child BMI: a comparison of Black Afro-Caribbean, White British and White German samples. *Eur J Clin Nutr* 2013; **67**(2)**:** 180-4.

21. Brug J, Uijtdewilligen L, van Stralen MM, Singh AS, Chin AMJ, De Bourdeaudhuij I *et al.* Differences in beliefs and home environments regarding energy balance behaviors according to parental education and ethnicity among schoolchildren in Europe: the ENERGY cross sectional study. *BMC Public Health* 2014; **14:** 610.

22. Evans A, Seth JG, Smith S, Harris KK, Loyo J, Spaulding C *et al.* Parental feeding practices and concerns related to child underweight, picky eating, and using food to calm differ according to ethnicity/race, acculturation, and income. *Matern Child Health J* 2011; **15**(7)**:** 899-909.

23. Cardel M, Willig AL, Dulin-Keita A, Casazza K, Beasley TM, Fernandez JR. Parental feeding practices and socioeconomic status are associated with child adiposity in a multi-ethnic sample of children. *Appetite* 2012; **58**(1)**:** 347-53.

24. Varela RE, Vernberg EM, Sanchez-Sosa JJ, Riveros A, Mitchell M, Mashunkashey J. Parenting style of Mexican, Mexican American, and Caucasian-non-Hispanic families: social context and cultural influences. *J Fam Psychol* 2004; **18**(4)**:** 651-7.

25. Loth KA, MacLehose RF, Fulkerson JA, Crow S, Neumark-Sztainer D. Eat this, not that! Parental demographic correlates of food-related parenting practices. *Appetite* 2013; **60**(1)**:** 140-7.

26. van de Gaar VM, Jansen W, van Grieken A, Borsboom G, Kremers S, Raat H. Effects of an intervention aimed at reducing the intake of sugar-sweetened beverages in primary school children: a controlled trial. *Int J Behav Nutr Phys Act* 2014; **11:** 98.

27. Swertz O DP, Thijssen J. . Statistics Netherlands. Migrants in the Netherlands 2004. *Voorburg/Heerlen, Netherlands: Statistics Netherlands* 2004.

28. Netherlands S. Dutch standard classification of education 2003. *Voorburg/Heerlen, Netherlands: Statistics Netherlands* 2004.

29. Bulk-Bunschoten AMW RC, Leerdam FJM, Hirasing RA. Protocol for detection of overweight in preventive youth health care. *VUMC: Amsterdam* 2004.

30. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000; **320**(7244)**:** 1240.

31. Wardle J, Sanderson S, Guthrie CA, Rapoport L, Plomin R. Parental feeding style and the inter-generational transmission of obesity risk. *Obes Res* 2002; **10**(6)**:** 453-62.

32. Veldhuis L, van Grieken A, Renders CM, Hirasing RA, Raat H. Parenting style, the home environment, and screen time of 5-year-old children; the 'be active, eat right' study. *PLoS ONE* 2014; **9**(2)**:** e88486.

33. De Bourdeaudhuij I, Te Velde SJ, Maes L, Perez-Rodrigo C, de Almeida MD, Brug J. General parenting styles are not strongly associated with fruit and vegetable intake and social-environmental correlates among 11-year-old children in four countries in Europe. *Public Health Nutr* 2009; **12**(2)**:** 259-66.

34. Lamborn SD, Mounts NS, Steinberg L, Dornbusch SM. Patterns of competence and adjustment among adolescents from authoritative, authoritarian, indulgent, and neglectful families. *Child Dev* 1991; **62**(5)**:** 1049-65.

35. Rosnow RL, Rosenthal R. Statistical procedures and the justification of knowledge in psychological science. *American Psychologist* 1989; **44**(10)**:** 1276.

36. Greenland S, Finkle WD. A critical look at methods for handling missing covariates in epidemiologic regression analyses. *Am J Epidemiol* 1995; **142**(12)**:** 1255-64.

37. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP *et al.* The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* 2007; **370**(9596)**:** 1453-7.

38. Dekker LH, Nicolaou M, van Dam RM, de Vries JH, de Boer EJ, Brants HA *et al.* Socio-economic status and ethnicity are independently associated with dietary patterns: the HELIUS-Dietary Patterns study. *Food Nutr Res* 2015; **59:** 26317.

39. Raaijmakers LGM, Gevers DWM, Teuscher D, Kremers SPJ, van Assema P. Emotional and instrumental feeding practices of Dutch mothers regarding foods eaten between main meals. *BMC Public Health* 2014; **14:** 171.

40. Birch LL, Birch D, Marlin DW, Kramer L. Effects of instrumental consumption on children's food preference. *Appetite* 1982; **3**(2)**:** 125-34.

41. Burrows TL, Martin RJ, Collins CE. A Systematic Review of the Validity of Dietary Assessment Methods in Children when Compared with the Method of Doubly Labeled Water. *Journal of the American Dietetic Association* 2010; **110**(10)**:** 1501-1510.

Supplements

Supplement 1. Table S1: Descriptive results of feeding style dimensions, parenting style dimensions, parenting style categories according to children's snacking behaviour

	Eating unhealthy snacks every day			Unhealthy snacks frequency per day		
	Yes	No	*P-value*[*]	<=1	>1	*P-value*[*]
Feeding style dimensions (mean (SD))						
Control over eating	3.07 (0.39)	3.08 (0.37)	0.921	3.09 (0.37)	3.05 (0.38)	0.248
Emotional feeding	1.75 (0.85)	1.78 (0.79)	0.784	1.73 (0.75)	1.88 (0.91)	**0.048**
Encouragement to eat	3.72 (0.70)	3.80 (0.65)	0.296	3.80 (0.68)	3.75 (0.62)	0.362
Instrumental feeding	2.11 (0.94)	2.16 (0.88)	0.636	2.13 (0.87)	2.20 (0.94)	0.370
Parenting style dimensions (mean (SD))						
Involvement	4.47 (0.53)	4.59 (0.38)	**0.011**	4.59 (0.39)	4.53 (0.45)	0.170
Strictness	4.57 (0.58)	4.50 (0.62)	0.317	4.53 (0.59)	4.45 (0.65)	0.139
Parenting style categories (n (%))						
Authoritative	38 (17.27)	182 (82.73)	**0.032**	159 (71.95)	62 (28.05)	0.123
Authoritarian	11 (15.71)	59 (84.29)		50 (71.43)	20 (28.57)	
Indulgent	4 (5.26)	72 (94.74)		57 (76.00)	18 (24.00)	
Neglectful	33 (17.19)	159 (82.81)		132 (69.11)	59 (30.89)	

[*]Continuous variables were compared using Wilcoxon text and categorical variables were compared using Chi-Square test.
Note: numbers printed in **bold** represent a significant association at $p<0.05$ between the independent variable and daily snack consumption.

Supplement 2. STROBE 2007 (v4) Statement – Checklist of items that should be included in reports of *cross-sectional studies*

Section/ Topic	#	Recommendation	Reported on page #
Title and abstract			
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	118
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	118
Introduction			
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	119
Objectives	3	State specific objectives, including any prespecified hypotheses	119
Methods			
Study design	4	Present key elements of study design early in the paper	120
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	120
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	120-122
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	121-123
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	121-123
Bias	9	Describe any efforts to address potential sources of bias	na
Study size	10	Explain how the study size was arrived at	120
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	121-123
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	123
		(b) Describe any methods used to examine subgroups and interactions	123
		(c) Explain how missing data were addressed	123
		(d) If applicable, describe analytical methods taking account of sampling strategy	na
		(e) Describe any sensitivity analyses	na

Supplement 2 (continued)

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study – e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	124
		(b) Give reasons for non-participation at each stage	na
		(c) Consider use of a flow diagram	na
Descriptive data	14*	(a) Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders	124
		(b) Indicate number of participants with missing data for each variable of interest	124
Outcome data	15*	Report numbers of outcome events or summary measures	126
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g.,,95% confidence interval). Make clear which confounders were adjusted for and why they were included	124-128
		(b) Report category boundaries when continuous variables were categorized	na
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	na
Other analyses	17	Report other analyses done – e.g., analyses of subgroups and interactions, and sensitivity analyses	128
Discussion			
Key results	18	Summarise key results with reference to study objectives	130-132
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	131
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	130-132
Generalisability	21	Discuss the generalisability (external validity) of the study results	130-132
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	120

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Part III:

Development and evaluation of interventions promoting healthy behaviours among children

6

Effectiveness of interventions to improve lifestyle behaviours among socially disadvantaged children in Europe

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Abstract

Background: Unhealthy lifestyle behaviours and childhood overweight are more common among children from families with a low socioeconomic position and ethnic minority children (referred to as social disadvantaged children). This systematic review evaluates the effectiveness of interventions aimed to improve lifestyle behaviours and/or prevent overweight among socially disadvantaged children in Europe.

Methods: Six major databases were searched for studies reporting intervention effects on adiposity measures, sedentary behaviours, physical activity behaviours or dietary behaviours. Studies were included when the study sample consisted of at least 50% socially disadvantaged children or when results were presented for subgroups of socially disadvantaged children separately. Methodological quality assessment was based on Cochrane criteria.

Results: In total, 11 studies reporting on eight interventions (one among infants 0 to 2 years old, one among pre-schoolers 2 to 6 years old, six among school-aged children 6 to 12 years old) were identified. Of these eight interventions, five interventions primarily aimed to improve at least one adiposity measure and three primarily aimed to improve a specific lifestyle behaviour. In general, modest positive effects were found but interventions were limited by a short follow-up duration.

Conclusions: Despite an urgent need for effective interventions to improve lifestyle behaviours and prevent overweight among socially disadvantaged children, research on the effectiveness of interventions in Europe is still scarce. Those interventions that have been evaluated show modest effects on lifestyle behaviours and adiposity measures, but long-term follow-up is needed to establish whether these effects are sustained over a longer period of time.

Background

Over the past three decades, childhood overweight has become a major public health concern [1]. In addition to an increased risk of overweight and obesity in adulthood [2], childhood overweight has been associated with adverse health outcomes during childhood, including (amongst others) type 2 diabetes, asthma, skeletomuscular difficulties and psychosocial problems [2, 3]. Within developed countries, childhood overweight is strongly socially patterned, dis- proportionally affecting children from low family socioeconomic position (SEP) and ethnic minority children (hereafter together referred to as socially disadvantaged children) [4, 5].

Although the etiology of overweight is multifactorial, involving both environmental and non-environmental (i.e., genetic) factors, there is general consensus that adverse changes in lifestyle behaviours have been a major determinant of the overweight epidemic [6]. This premise has been substantiated by a wealth of observational research, showing both cross-sectional and longitudinal associations between lifestyle behaviours and childhood overweight [6-8]. Furthermore, interventions targeting these lifestyle behaviours have been shown to have modest effects on adiposity measures [9, 10]. There is evidence to suggest that lifestyle behaviours are established in early childhood [11] and track into adolescence and young adulthood [12], warranting preventive efforts in early childhood. Studies on the effectiveness of interventions aimed to improve lifestyle behaviours and/or prevent overweight among socially disadvantaged children are scarce and have mainly been conducted in the USA and Oceania [9, 10, 13]. Given differences in cultural and immigration backgrounds, findings of these studies cannot be generalized to European populations of socially disadvantaged children. Furthermore, US interventions among ethnic minority groups are usually performed in one specific ethnic group (e.g., African American or Hispanic children) [9, 10, 13], while European ethnic minority populations are often more diverse. Therefore, the aim of this systematic review is to synthesize the evidence on the effectiveness of interventions aimed to improve lifestyle behaviours and/or prevent overweight among young socially disadvantaged children (0- to 12-year-olds) in Europe.

Methods

Literature search

A systematic literature search was conducted in PubMed, EMBASE, Web of Science, Medline (OvidSP), Google Scholar and Cochrane Database of Systematic Reviews in November 2013. The complete search strategies can be found in Supplement 1. The search strategy was initially designed for PubMed and then adapted for all other databases. Furthermore, references of manuscripts were searched for additional studies not identified by the original search strategy. A search update was performed in April 2016.

Inclusion criteria

To be eligible for inclusion, studies had to be published in an English spoken peer-reviewed journal after 31 December 1989. Studies were included when they reported on at least one of the following variables as 'primary outcome measure': adiposity measures [i.e., Body Mass Index (BMI), weight status, waist circumference, skin fold thickness, percentage body fat], sedentary behaviours (i.e., screen time), physical activity behaviours [i.e., habitual physical activity (low, moderate and vigorous physical activity/daily steps), sports participation] or dietary behaviours [i.e., consumption of sugar sweetened beverages (SSB), breakfast consumption]. These specific behaviours were selected based on systematic reviews showing substantial evidence of an association with childhood overweight [6, 14]. Two types of studies were included in this review on the basis of presenting intervention effects for socially disadvantaged children: (i) studies with a study sample of at least 50% socially disadvantaged children [15], or (ii) studies reporting subgroup results for socially disadvantaged children separately.

Socially disadvantaged children were defined as children with a non-native ethnic background/immigrant status or children from families with a low SEP (i.e., low parental educational level, low household income, low parental occupational class, or living in low income/deprived areas) [16]. Inclusion was restricted to studies among infants (0 to 2 year olds), preschool children (2 to 6 year olds) and primary school children (6 to 12 year olds) in Europe. Inclusion was furthermore limited to studies with a rigorous study design, i.e., (randomized) controlled trials with a concurrent control group.

Exclusion criteria

Studies among secondary school children/adolescents (i.e., age >12.0 years old) were excluded. In case of studies conducted among a combination of primary and secondary school children (e.g., 7 to 14 year old children), exclusion was based on the mean age of the population. Studies without a rigorous study design, e.g., post-measurements only, pre- and post-test measurements without a proper control group, or observational studies, were excluded. Furthermore, intervention studies performed in laboratory settings, intervention studies performed among overweight/obese children only (i.e., 'treatment interventions'), and studies not reporting intervention effects for socially disadvantaged children were excluded.

Selection process

Titles and abstracts were independently reviewed by two authors (AW and VvdG) to make the initial selection of relevant intervention studies. Then, reference lists were screened for other potentially relevant studies. All studies identified between the two reviewers were reviewed using full text by both reviewers (AW and VvdG) and in the case of discrepant findings, a third party (HR) was consulted until consensus was achieved.

Results

Search results

The original search strategy identified 6080 unique studies. After the selection process based on the formulated inclusion and exclusion criteria, six studies were eligible for inclusion in this review. Even though some studies could be excluded based on multiple exclusion criteria, a study is attributed one exclusion criterion only (top to bottom), thus adding up to hundred percent (see Figure 1). The updated search identified an additional five studies. In total, 11 studies evaluating eight interventions were included in this systematic review.

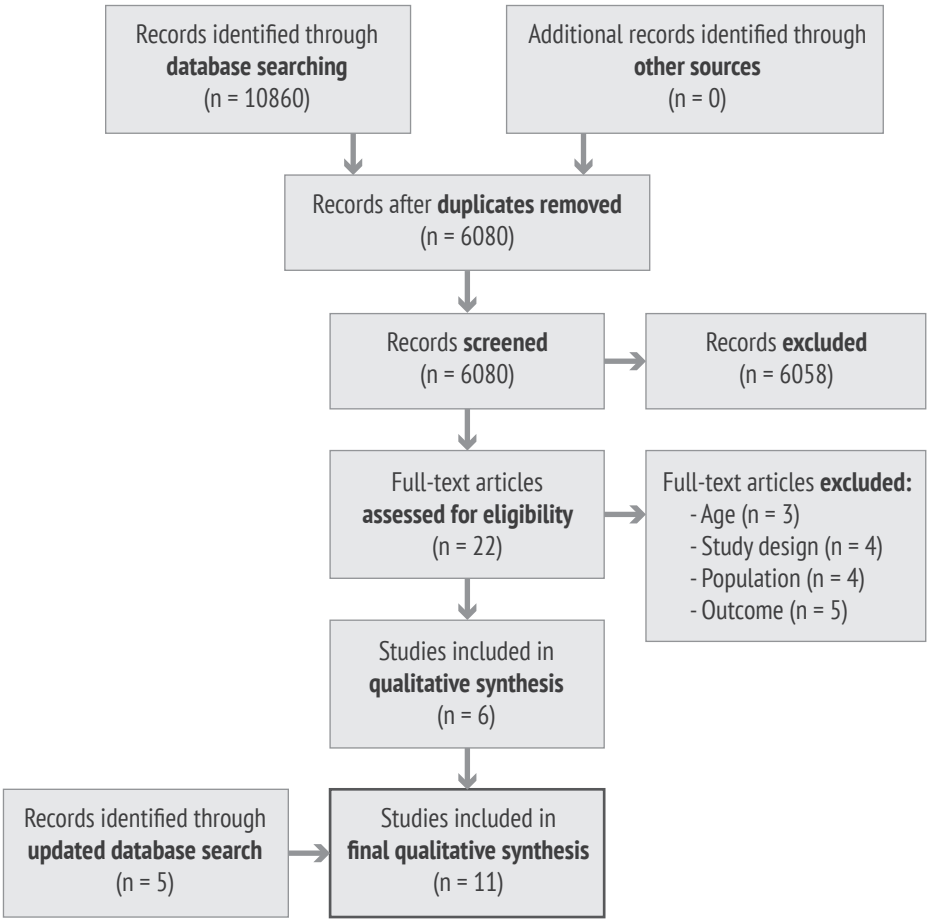

Figure 1. Flow chart of selection process

Interventions

A description of the studies is presented in Table 1. Most interventions aimed primarily to improve adiposity measures [17-23], with a minority primarily aiming to promote physical activity [24-26] or reduce consumption of SSB [27]. All but one of the interventions was based in the school setting [21], one targeting preschool children [18, 23] and all others targeting primary school children [17, 19, 20, 22, 24-27]. More detailed information on the content of these interventions can be found in Supplement 2, Table S1. Although process evaluation of the included studies is outside the scope of this review, methodological quality of the included studies was assessed according to Cochrane criteria (Supplements 3, Tables S2–S4)[28].

Table 1: Description of included studies (n=11)

Study	Study population	Setting	Study design	N[a]	Age[b]
McEachan et al. 2016 [21]	Overweight and obese pregnant women. 71% non-white British. 63% < degree level. Bradford, UK.	Community	RCT	120	-14 weeks old
Puder et al. 2011 [23]	Predominantly migrant preschool children of multicultural origin. 72% migrant children. 38% children of families with a low educational level. Switzerland.	Preschool	RCT	652	5.2 years old
Burgi et al. 2012 [18][c]	Predominantly migrant preschool children of multicultural origin. 72% migrant children. 38% children of families with a low educational level. Switzerland.	Preschool	RCT	652 (472, 213)	5.2 years old
Adab et al. 2014 [17]	Primary school children. 86% South Asian background. Birmingham, UK.	School	CT	574	6.5 years old
Cezard et al. 2016 [19]	Primary school children. 86% South Asian background. Birmingham, UK.	School	CT	466	6.5 years old
Jansen et al. 2011 [20]	Primary school children in deprived inner-city areas. Primarily non-native Dutch children. Rotterdam, the Netherlands	School	RCT	2622	6-12 years old
Muckelbauer et al. 2010 [22][c]	Primary school children from low socioeconomic districts. 44% immigrant children. Germany.	School	CT	3190 (1407)	8.3 years old
de Meij et al. 2011 [24][c]	Primary school children in socially and economically deprived areas. 85% non-native Dutch children. Amsterdam, the Netherlands.	School	CT	2848 (872, 529)	8.6 years old
van Stralen et al. 2012 [26]	Primary school children in socially and economically deprived areas. 87% non-native Dutch children. Amsterdam, the Netherlands.	School	CT	600	9.8 years old
Van de Gaar et al. 2014 [27]	Primary school children in multi-ethnic, disadvantaged neighbourhoods. Primarily non-native Dutch children. Rotterdam, the Netherlands.	School	CT	1175	6-12 years old
Eyre et al. 2016 [25]	Deprived primary school children. 100% South Asian children. Coventry, UK.	School	CT	134	9-11 years old

RCT = randomized controlled trial; CT = controlled trial; [a] Sample size at baseline; [b] Age at baseline; [c] Number in bracket for study sample is the number of immigrant/low SEP children

Intervention effectiveness

An overview of intervention effects can be found in Table 2. In sum, all interventions targeting multiple lifestyle behaviours had a positive effect on at least one adiposity measure (Table 2, Table S1) [17-21, 23]. In contrast, those interventions targeting one specific lifestyle behaviour were effective only in changing that behaviour (i.e., water consumption [22], physical activity [24, 26], consumption of SSB [27]), and had no effect [22, 24] or an adverse effect [27] on adiposity measures. An exception to this general notion is the physical activity intervention by Eyre et al. [25], which resulted in increases in physical activity levels and decreases in percentage body fat and waist circumference. Furthermore, no spill-over effects on other lifestyle behaviours were observed for these interventions [22, 26, 27].

Table 2: Intervention effects of included studies (n=11)

Study	Anthropometrics	Physical activity behaviours	Sedentary behaviours	Dietary behaviours
McEachan et al. [21][a]	(P) Weight SDS: -0.25 (-0.65,0.16) (S) Conditional weight gain > 1 centile band: **0.29 (0.10,0.85)** (S) Conditional weight gain > 2 centile bands: 0.38 (0.10,1.49) (S) Weight >85th centile at 12 months: 0.50 (0.15,1.64)			
Puder et al. [23][a]	(P) BMI (kg/m^2): -0.07 (-0.19,0.06) (S) Overweight (%): 0.65 (0.32,1.32) (S) Body fat (%): -1.1 **(-2.02,-0.20)** (S) Waist circumference (cm): **-1.0 (-1.6,-0.42)** (S) Sum of skinfolds (mm): **-2.78 (-4.35,-1.2)**	(S) Objectively measured PA (CPM): -12.3 (-51.5,26.9)	(S) Media use: **-13.4 (-25.0,-1.7)**	
Burgi et al. [18][a]	*'Immigrant children'* (P) BMI (kg/m^2): -0.05 (-0.18,0.08) (S) Body fat (%): **-1.14 (-2.06,-0.22)** (S) Waist circumference (cm): **-1.02 (-1.69,-0.36)** *'Low SEP children'* (P) BMI (kg/m^2): 0.04 (-0.15,0.23) (S) Body fat (%): -0.43 (-1.63,0.77) (S) Waist circumference (cm): **-1.10 (-2.0,-0.20)**			

Study	Anthropometrics	Physical activity behaviours	Sedentary behaviours	Dietary behaviours
Adab et al. [17][a]	(P) BMI (kg/m^2): **-0.15 (-0.27,-0.03)** (S) Obese (%): **0.41 (0.19,0.89)** (S) Waist circumference (cm): -0.86 (-1.87,0.15) (S) Sum of skinfolds (mm): -0.97 (-2.70,0.77)	(S) Objectively measured PA (CPM): -0.18 (-0.36,0.01)		
Cezard et al. [19][b]	*'Boys'* (P) BMI (kg/m^2): Control group: 0.8 (0.2,1.6) Intervention group: 0.7 (-0.0,1.5) (S) Waist circumference (cm): Control group: 3.8 (2.3,6.2) Intervention group: 4.0 (1.3,6.9) (S) Skinfolds (mm): Control group: 2.9 (-2.1,11.5) Intervention group: 2.8 (-1.3,12.1) *'Girls'* (P) BMI (kg/m^2): Control group: **1.1 (0.4,2.4)** Intervention group: **0.6 (-0.6,1.78)** (S) Waist circumference (cm): Control group: **5.3 (2.5,9.0)** Intervention group: **3.0 (0.3,5.8)** (S) Skinfolds (mm): Control group: 7.0 (-3.4,17.9) Intervention group: 0.3 (-2.4,11.5)			
Jansen et al. [20][a]	*'Grades 3-5'* (P) BMI (kg/m^2): -0.10 (-0.22,0.03) (P) Overweight (%): **0.53 (0.36,0.78)** (P) Waist circumference (cm): **-1.29 (-2,16,-0.42)** *'Grades 6-8'* (P) BMI (kg/m^2): 0.03 (-0.12,0.17) (P) Overweight (%): 1.25 (0.79,1.99) (P) Waist circumference (cm): (-0.71,-1.72,0.29)			
Muckelbauer et al. [22][a]	(P) Overweight (%): 1.02 (0.63,1.65)			(S) Consumption of water (glasses/day): **1.0 (0.6,1.4)** (S) Consumption of soft drinks (glasses/day): -0.1 (-0.3,0.1)

Study	Anthropometrics	Physical activity behaviours	Sedentary behaviours	Dietary behaviours
de Meij et al. [24][a]	(S) BMI (kg/m^2): 0.07 (-0.02,0.16) (S) Waist circumference (cm): 0.3 (-0.15,0.75)	(P) Sports participation: **2.8 (2.18,3.62)** (P) Objectively measured PA (CPM): 40 (-27,106) *'Turkish children'* (P) Sports participation: **3.2 (1.91,5.21)** *'Moroccan children'* (P) Sports participation: **4.2 (3.63,5.7)**		
van Stralen et al. [26][a]	(P) Sports participation: **2.68 (1.60,4.46)**		(S) TV viewing (times/week): 0.58 (-0.26,1.43) (S) Computer use (times/week): 0.36 (-0.35,1.08)	
Van de Gaar et al. [27][a]	(S) BMI (kg/m^2): **0.26 (0.11,0.40)**			*'Parent report'* (P) Consumption of SSB (L): **-0.19 (-0.28,-0.10)** (P) Consumption of SSB (no.): **-0.54 (-0.82,-0.26)** *'Child report'* (P) Consumption of SSB (L): 0.04 (-0.10,0.19) (P) Consumption of SSB (no.): 0.05 (-0.36,0.47)
Eyre et al. 2016 [25][c]	(S) BMI (kg/m^2): Control group: -1.94 (±0.93) Intervention group: -0.21 (±0.88) (S) Waist circumference (cm): Control group: **-0.21 (±3.49)** Intervention group: **-1.73 (±4.48)** (S) Body fat (%): Control group: **-1.09 (±2.77)** Intervention group: **-4.46 (±4.77)**	(P) Daily steps: Control group: **-1121 (±5592)** Intervention group**: 8694 (±4929)**		

(P) primary outcome; (S) secondary outcome; (CPM) Counts per minute; (L) liters; (no.) number of servings; Bold print indicates significance.

[a] Values represent intervention effects, i.e., differences between intervention and control group (reference group). Differences in continuous outcomes are presented by beta's (95% CI) and difference in categorical outcomes are presented by odds ratios (95% CI). Where possible, fully adjusted differences are presented.

[b] Values represent median change (1-3 quartile) from baseline to follow-up for control and intervention groups.

[c] Values represent mean change (± standard deviation) from baseline to follow-up for control and intervention groups.

Discussion

This systematic review aimed to synthesize the evidence on the effectiveness of interventions aimed to improve lifestyle behaviours and/or prevent overweight among 0- to 12-year-old socially disadvantaged children in Europe. The search yielded a limited number of studies, especially among children under the age of 6 years old. In general, interventions targeting multiple lifestyle behaviours were moderately effective in positively influencing at least one adiposity measure, while interventions targeting one specific behaviour were moderately effective in changing that behaviour but not adiposity measures.

Intervention effectiveness

Those interventions targeting multiple lifestyle behaviours and individual level determinants, family-level determinants, and environmental determinants thereof were shown to positively influence adiposity measures. These findings are plausible given the complex etiology of childhood overweight involving risk factors from all domains ranging from the most proximal lifestyle behaviours to wider environmental and societal determinants [1, 9, 10, 16]. Notably, one of these interventions seemed to positively affect adiposity measures only in girls and not boys, possibly due to differential adherence to specific intervention components. In a similar vein, another intervention seemed to positively affect adiposity measures in younger children but not in older children. More research into potential gender and age differences in intervention effectiveness among socially disadvantaged children is merited.

In contrast, those interventions targeting specific lifestyle behaviours were effective in changing those lifestyle behaviours but not adiposity measures or related lifestyle behaviours. These results can be used to inform intervention designers that they should not, be default, rely on assumed spill-over effects (e.g., effect of a physical activity intervention on screen time or effect of a water consumption intervention on soft drinks) but rather should target the behaviours that they aim to improve.

Evidence suggests that cultural adaptation has the potential to enhance intervention relevance, effectiveness, and feasibility of interventions for ethnic minority groups

especially [29]. Indeed, substantial positive effects of those interventions with cultural tailoring (Table S1) offer support to the premise that cultural tailoring may an important element of effective interventions for socially disadvantaged children. However, the observation that more environment-focused interventions without any apparent cultural tailoring also positively affected children's lifestyle behaviours and/or adiposity measures supports research showing that interventions in low socioeconomic groups will be most effective when structural barriers constraining healthy choices are removed [30].

Methodological considerations

Some methodological considerations should be taken into account when interpreting the effectiveness of the interventions included in this review. Studies reporting effect estimates for subgroups were not initially designed for testing interaction effects and conducting subgroup analyses, and therefore may lack power to detect significant effects in subgroups. Similarly, feasibility studies included in this review may not have been powered sufficiently to examine intervention outcomes. Furthermore, effect evaluations were generally performed immediately post intervention, thus precluding any conclusions regarding long-term intervention effects. Although process evaluation of included studies was outside the scope of this review, an assessment of the quality of included studies was performed (Tables S2–S4). In general, studies included in this review scored low risk or unclear risk on most criteria. The most common limitations included lack of blinding of participants (often not possible due to nature of interventions) and the use of questionnaires in the assessment of lifestyle behaviours, which together may have led to socially desirable answering [31].

Research gaps

Based on this systematic review, a number of research gaps can be identified. First and foremost, we found that the number of studies investigating the effectiveness of interventions aimed to improve lifestyle behaviours and/or adiposity measures among socially disadvantaged children in Europe is still scarce, especially among young children (i.e., <6 years old). Based on current evidence that very young children already display unhealthy lifestyle behaviours such as high screen time and consumption of SSB [32, 33],

intervening at a young age seems paramount. Furthermore, included studies were limited to Northern and Western Europe and thus indicate a need for more research in Southern and Eastern European countries where social inequalities in lifestyle behaviours and overweight also exist [4, 34, 35]. Third, with the exception of one community based intervention, all interventions were conducted in the (pre)school setting, hampering conclusions regarding differential effects according to intervention setting. The school setting offers major advantages that may be especially important for socially disadvantaged children [18, 24], including easily implemented changes in the school without need for parental involvement or motivation, the mandatory character of interventions elements (e.g., school curriculum changes and changes in the environment), and a large reach across all social groups. However, prevention in early childhood also requires interventions outside the school setting. Furthermore, previous research has shown that the effectiveness of school-based interventions can be substantially improved by incorporating family and community components [36, 37]. Fourth, this review identified only one intervention that primarily aimed to reduce SSB consumption and no studies that primarily aimed to reduce screen time. This finding is surprising given that SSB consumption and screen time, television viewing in particular, are two major risk factors of childhood overweight [6, 7] that are more common among socially disadvantaged children [38, 39]. Finally, long-term follow up of interventions is needed to confirm whether positive intervention effects are sustained over a long period of time.

Review strengths and limitations

The main strength of this review is the extensive systematic literature search performed in multiple databases. A number of limitations should be considered when interpreting our results. This systematic review relied on studies published in English spoken, peer-reviewed journals in the past 25 years. As a consequence, studies published in other languages and/or published before 1990 have not been included in this review. Perhaps even more important, publication bias favouring studies showing significant intervention effects over studies showing no interventions effects may have biased the results. Socially disadvantaged children were defined as ethnic minority children and low SEP children. It should be acknowledged that although highly related, ethnic background and family SEP are different socio-demographic characteristics likely to moderate the associations of risk

factors with children's lifestyle behaviours and adiposity measures. Furthermore, studies were included only when the study sample consisted of at least 50% socially disadvantaged children to ensure that the study results would be informative for socially disadvantaged children. Albeit this cut-off point was used to reach uniformity in study inclusion and based on previous research [15], the cut-off point itself is arbitrary and may have led to exclusion of potentially informative studies (e.g., non-stratified results by Muckelbauer et al. [40]). Process evaluation and evaluation of the effectiveness of secondary prevention interventions, or so called 'treatment' interventions, were outside the scope of the current review, precluding any conclusions regarding important process variables (e.g., intervention reach and sustainable implementation) and recommendations on how best to 'treat' childhood overweight among socially disadvantaged children in Europe. Also outside the scope of this review was the assessment of the effect of interventions on reducing social inequalities in children's lifestyle behaviours and adiposity. When implementing an intervention in the general population that is more effective among non-socially disadvantaged children compared with socially disadvantaged children, social inequalities may increase even when socially disadvantaged children benefit from the intervention [41]. This systematic review was limited to studies employing rigorous study designs, i.e., (randomized) controlled trials with a concurrent control group. As a consequence, broader policies that may be especially effective in improving lifestyle behaviours and adiposity among socially disadvantaged children (e.g., tax policies, policies to ban unhealthy-food advertisement, policies for changing the built environment) [30] and that are difficult to assess by (randomized) controlled trials [30, 41] were excluded from this review. Finally, meta- analysis of the results was not possible due to the heterogeneity in study populations, interventions, outcome measures and statistical analyses.

Conclusion

Given the high prevalence of unhealthy lifestyle behaviours and childhood overweight among socially disadvantaged children in Europe, preventive interventions are highly warranted. This systematic review shows that 'although the relevant evidence base is

involving, it is not keeping pace with the need for solutions' (p. 178) [15]. Those interventions that have been evaluated show modest effects on adiposity measures and lifestyle behaviours, but long-term follow-up is needed to establish whether these effects are sustained over a longer period of time.

References

1. Lobstein T, Baur L, Uauy R, TaskForce IIO. Obesity in children and young people: a crisis in public health. *Obes Rev* 2004; **5 Suppl 1:** 4-104.
2. Reilly JJ, Methven E, McDowell ZC, Hacking B, Alexander D, Stewart L *et al.* Health consequences of obesity. *Arch Dis Child* 2003; **88**(9)**:** 748-52.
3. Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics* 1998; **101**(3 Pt 2)**:** 518-25.
4. Ahrens W, Pigeot I, Pohlabeln H, De Henauw S, Lissner L, Molnar D *et al.* Prevalence of overweight and obesity in European children below the age of 10. *Int J Obes (Lond)* 2014; **38 Suppl 2:** S99-107.
5. Zilanawala A, Davis-Kean P, Nazroo J, Sacker A, Simonton S, Kelly Y. Race/ethnic disparities in early childhood BMI, obesity and overweight in the United Kingdom and United States. *Int J Obes (Lond)* 2015; **39**(3)**:** 520-9.
6. Rennie KL, Johnson L, Jebb SA. Behavioural determinants of obesity. *Best Pract Res Clin Endocrinol Metab* 2005; **19**(3)**:** 343-58.
7. Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: a systematic review. *Am J Clin Nutr* 2006; **84**(2)**:** 274-88.
8. Must A, Tybor DJ. Physical activity and sedentary behavior: a review of longitudinal studies of weight and adiposity in youth. *Int J Obes (Lond)* 2005; **29 Suppl 2:** S84-96.
9. Summerbell CD, Waters E, Edmunds LD, Kelly S, Brown T, Campbell KJ. Interventions for preventing obesity in children. *Cochrane Database Syst Rev* 2005; (3)**:** CD001871.
10. Waters E, de Silva-Sanigorski A, Hall BJ, Brown T, Campbell KJ, Gao Y *et al.* Interventions for preventing obesity in children. *Cochrane Database Syst Rev* 2011; (12)**:** CD001871.
11. Reilly JJ. Physical activity, sedentary behaviour and energy balance in the preschool child: opportunities for early obesity prevention. *Proc Nutr Soc* 2008; **67**(3)**:** 317-25.
12. Pearson N, Salmon J, Campbell K, Crawford D, Timperio A. Tracking of children's body-mass index, television viewing and dietary intake over five-years. *Prev Med* 2011; **53**(4-5)**:** 268-70.
13. Laws R, Campbell KJ, van der Pligt P, Russell G, Ball K, Lynch J *et al.* The impact of interventions to prevent obesity or improve obesity related behaviours in children (0-5 years) from socioeconomically disadvantaged and/or indigenous families: a systematic review. *BMC Public Health* 2014; **14:** 779.
14. Must A, Barish EE, Bandini LG. Modifiable risk factors in relation to changes in BMI and fatness: what have we learned from prospective studies of school-aged children? *Int J Obes (Lond)* 2009; **33**(7)**:** 705-15.
15. Kumanyika SK, Swank M, Stachecki J, Whitt-Glover MC, Brennan LK. Examining the evidence for policy and environmental strategies to prevent childhood obesity in black communities: new directions and next steps. *Obes Rev* 2014; **15 Suppl 4:** 177-203.
16. Galobardes B, Lynch J, Smith GD. Measuring socioeconomic position in health research. *Br Med Bull* 2007; **81-82:** 21-37.

17. Adab P, Pallan MJ, Cade J, Ekelund U, Barrett T, Daley A *et al.* Preventing childhood obesity, phase II feasibility study focusing on South Asians: BEACHeS. *BMJ Open* 2014; **4**(4)**:** e004579.

18. Burgi F, Niederer I, Schindler C, Bodenmann P, Marques-Vidal P, Kriemler S *et al.* Effect of a lifestyle intervention on adiposity and fitness in socially disadvantaged subgroups of preschoolers: a cluster-randomized trial (Ballabeina). *Prev Med* 2012; **54**(5)**:** 335-40.

19. Cezard G, Bansal N, Bhopal R, Pallan M, Gill P, Barrett T *et al.* Adiposity and response to an obesity prevention intervention in Pakistani and Bangladeshi primary school boys and girls: a secondary analysis using the BEACHeS feasibility study. *BMJ Open* 2016; **6**(2)**:** e007907.

20. Jansen W, Borsboom G, Meima A, Zwanenburg EJ, Mackenbach JP, Raat H *et al.* Effectiveness of a primary school-based intervention to reduce overweight. *Int J Pediatr Obes* 2011; **6**(2-2)**:** e70-7.

21. McEachan RR, Santorelli G, Bryant M, Sahota P, Farrar D, Small N *et al.* The HAPPY (Healthy and Active Parenting Programmme for early Years) feasibility randomised control trial: acceptability and feasibility of an intervention to reduce infant obesity. *BMC Public Health* 2016; **16:** 211.

22. Muckelbauer R, Libuda L, Clausen K, Toschke AM, Reinehr T, Kersting M. Immigrational background affects the effectiveness of a school-based overweight prevention program promoting water consumption. *Obesity (Silver Spring)* 2010; **18**(3)**:** 528-34.

23. Puder JJ, Marques-Vidal P, Schindler C, Zahner L, Niederer I, Burgi F *et al.* Effect of multidimensional lifestyle intervention on fitness and adiposity in predominantly migrant preschool children (Ballabeina): cluster randomised controlled trial. *BMJ* 2011; **343:** d6195.

24. de Meij JS, Chinapaw MJ, van Stralen MM, van der Wal MF, van Dieren L, van Mechelen W. Effectiveness of JUMP-in, a Dutch primary school-based community intervention aimed at the promotion of physical activity. *Br J Sports Med* 2011; **45**(13)**:** 1052-7.

25. Eyre EL, Cox VM, Birch SL, Duncan MJ. An integrated curriculum approach to increasing habitual physical activity in deprived South Asian children. *Eur J Sport Sci* 2016; **16**(3)**:** 381-90.

26. van Stralen MM, de Meij J, Te Velde SJ, van der Wal MF, van Mechelen W, Knol DL *et al.* Mediators of the effect of the JUMP-in intervention on physical activity and sedentary behavior in Dutch primary schoolchildren from disadvantaged neighborhoods. *Int J Behav Nutr Phys Act* 2012; **9:** 131.

27. van de Gaar VM, Jansen W, van Grieken A, Borsboom G, Kremers S, Raat H. Effects of an intervention aimed at reducing the intake of sugar-sweetened beverages in primary school children: a controlled trial. *Int J Behav Nutr Phys Act* 2014; **11:** 98.

28. The Cochrane Collaboration. *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0* [update March 2011].

29. Nierkens V, Hartman MA, Nicolaou M, Vissenberg C, Beune EJ, Hosper K *et al.* Effectiveness of cultural adaptations of interventions aimed at smoking cessation, diet, and/or physical activity in ethnic minorities. a systematic review. *PLoS ONE* 2013; **8**(10)**:** e73373.

30. Backholer K, Beauchamp A, Ball K, Turrell G, Martin J, Woods J *et al.* A framework for evaluating the impact of obesity prevention strategies on socioeconomic inequalities in weight. *Am J Public Health* 2014; **104**(10)**:** e43-50.

31. Taber DR, Stevens J, Murray DM, Elder JP, Webber LS, Jobe JB *et al.* The effect of a physical activity intervention on bias in self-reported activity. *Ann Epidemiol* 2009; **19**(5)**:** 316-22.

32. Certain LK, Kahn RS. Prevalence, correlates, and trajectory of television viewing among infants and toddlers. *Pediatrics* 2002; **109**(4)**:** 634-42.

33. Garnett BR, Rosenberg KD, Morris DS. Consumption of soda and other sugar-sweetened beverages by 2-year-olds: findings from a population-based survey. *Public Health Nutr* 2013; **16**(10)**:** 1760-7.

34. Inchley J, Currie D, Young T, Samdal O, Torsheim T, Augustson L *et al. Growing up unequal: gender and socioeconomic differences in young people's health and well-being. Health Behaviour in School-aged Children (HBSC) study: international report from the 2013/2014 survey*. WHO Regional Office for Europe: Copenhagen, 2016.

35. van Stralen MM, te Velde SJ, van Nassau F, Brug J, Grammatikaki E, Maes L *et al.* Weight status of European preschool children and associations with family demographics and energy balance-related behaviours: a pooled analysis of six European studies. *Obes Rev* 2012; **13 Suppl 1:** 29-41.

36. Bleich SN, Segal J, Wu Y, Wilson R, Wang Y. Systematic review of community-based childhood obesity prevention studies. *Pediatrics* 2013; **132**(1)**:** e201-10.

37. Katz DL, O'Connell M, Njike VY, Yeh MC, Nawaz H. Strategies for the prevention and control of obesity in the school setting: systematic review and meta-analysis. *Int J Obes (Lond)* 2008; **32**(12)**:** 1780-9.

38. Wijtzes AI, Jansen W, Jansen PW, Jaddoe VW, 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* 2013; **57**(5)**:** 607-12.

39. Wijtzes AI, Jansen W, Kamphuis CB, Jaddoe VW, Moll HA, Tiemeier H *et al.* Increased risk of exceeding entertainment-media guidelines in preschool children from low socioeconomic background: the Generation R Study. *Prev Med* 2012; **55**(4)**:** 325-9.

40. Muckelbauer R, Libuda L, Clausen K, Toschke AM, Reinehr T, Kersting M. Promotion and provision of drinking water in schools for overweight prevention: randomized, controlled cluster trial. *Pediatrics* 2009; **123**(4)**:** e661-7.

41. Mackenbach JP, Gunning-Schepers LJ. How should interventions to reduce inequalities in health be evaluated? *J Epidemiol Community Health* 1997; **51**(4)**:** 359-64.

Supplements

Supplement 1. Search strategy

PubMed

((((lifestyle[tiab] OR life style[tiab] OR body mass[tiab] OR body weight[tiab] OR weight gain*[tiab] OR weight chang*[tiab] OR weight control*[tiab] OR weight fluctuat*[tiab] OR weight reduc*[tiab] OR bmi[tiab] OR Quetelet[tiab] OR obes*[tiab] OR adiposit*[tiab] OR overweight*[tiab] OR over weight*[tiab] OR physical activ*[tiab] OR physically inactiv*[tiab] OR sedentary[tiab] OR diet[tiab] OR dietary[tiab] OR food[tiab] OR feeding[tiab] OR eating[tiab] OR Portion siz*[tiab] OR excessive intake*[tiab])) AND ((intervention*[tiab] OR program*[tiab] OR promotion*[tiab] OR promoting[tiab]))))) AND ((migrant*[tiab] OR immigrant*[tiab] OR ethnic*[tiab] OR multiethnic*[tiab] OR minorit*[tiab] OR race[tiab] OR racial[tiab] OR african*[tiab] OR hispanic[tiab] OR asian[tiab] OR low income*[tiab] OR lower income*[tiab] OR lowest income*[tiab] OR povert*[tiab] OR poorer[tiab] OR underserv*[tiab] OR under serv*[tiab])) AND ((child*[tiab] OR schoolchild*[tiab] OR preschool*[tiab] OR pre school*[tiab])) AND ((evaluat*[tiab] OR effect*[tiab] OR efficac*[tiab] OR follow up*[tiab] OR followup[tiab] OR outcome*[tiab] OR assesment*[tiab])) AND publisher[sb]

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promotion'/de OR 'voluntary program'/de OR (intervention* OR program* OR promotion* OR promoting):ab,ti))) AND (migration/exp OR immigrant/de OR 'cultural factor'/de OR 'ethnic and racial groups'/exp OR 'minority group'/de OR 'ethnic difference'/de OR 'race difference'/de OR 'lowest income group'/de OR Poverty/de OR (migrant* OR immigrant* OR ethnic* OR multiethnic* OR minorit* OR race OR racial OR african* OR hispanic OR asian OR (low* NEXT/1 income*) OR povert* OR poorer OR underserv* OR (under NEXT/1 serv*)):ab,ti) AND (child/exp OR 'childhood obesity'/de OR childhood/de OR 'child behavior'/de OR 'child nutrition'/de OR 'child health'/de OR (child* OR schoolchild* OR preschool* OR (pre NEXT/1 school*)):ab,ti) AND (evaluation/de OR 'evaluation research'/de OR 'follow up'/de OR 'outcome assessment'/de OR (evaluat* OR effect* OR efficac* OR (follow* NEXT/1 up*) OR followup OR outcome* OR assesment*):ab,ti) NOT ([Conference Abstract]/lim OR [Conference Paper]/lim OR [Conference Review]/lim OR [Editorial]/lim OR [Erratum]/lim OR [Letter]/lim) AND [english]/lim

Web of Science

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Medline (OvidSP)

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OR overweight* OR (over ADJ weight*) OR (physical* ADJ3 (activ* OR inactiv*)) OR sedentary OR diet* OR food OR feeding OR eating OR (Portion ADJ siz*) OR (excess* ADJ3 intake*)).ab,ti.) AND ("Intervention Studies"/ OR "Program Evaluation"/ OR exp "health promotion"/ OR (intervention* OR program* OR promotion* OR promoting).ab,ti.))) AND (exp "Human Migration"/ OR "Emigrants and Immigrants"/ OR exp "Ethnic Groups"/ OR "Minority Groups"/ OR "ethnology".xs. OR exp Poverty/ OR (migrant* OR immigrant* OR ethnic* OR multiethnic* OR minorit* OR race OR racial OR african* OR hispanic OR asian OR (low* ADJ income*) OR povert* OR poorer OR underserv* OR (under ADJ serv*)).ab,ti.) AND (exp child/ OR exp "child behavior"/ OR "Child Nutritional Physiological Phenomena"/ OR (child* OR schoolchild* OR preschool* OR (pre ADJ school*)).ab,ti.) AND ("Program Evaluation"/ OR "Evaluation Studies".pt. OR "Follow-Up Studies"/ OR "Outcome Assessment (Health Care)"/ OR (evaluat* OR effect* OR efficac* OR (follow* ADJ up*) OR followup OR outcome* OR assesment*).ab,ti.) NOT (Congresses OR Editorial OR Erratum OR Letter).pt. AND english.la.

Google Scholar

(lifestyle|"life style"|"body (mass|weight)"|"weight (gain|reduction)"|bmi|obesity|overweight exercise|diet|dietary) (intervention|program|promotion) (migrants|ethnic|minorities|"low income"|poverty) (child|children) (evaluation|effectivity|efficacy)

Cochrane

((((lifestyle OR 'life style' OR (body NEXT/1 (mass OR weight)) OR (weight NEAR/3 (gain OR chang* OR control* OR fluctuat* OR reduc*)) OR bmi OR Quetelet OR obes* OR adiposit* OR overweight* OR (over NEXT/1 weight*) OR (physical* NEAR/3 (activ* OR inactiv*)) OR exerci* OR sedentary OR diet* OR food OR feeding OR eating OR (Portion NEXT/1 siz*) OR (excess* NEAR/3 intake*)):ab,ti) AND ((intervention* OR program* OR promotion* OR promoting):ab,ti))) AND ((migrant* OR immigrant* OR ethnic* OR multiethnic* OR minorit* OR race OR racial OR african* OR hispanic OR asian OR (low* NEXT/1 income*) OR povert* OR poorer OR underserv* OR (under NEXT/1 serv*)):ab,ti) AND ((child* OR schoolchild* OR preschool* OR (pre NEXT/1 school*)):ab,ti) AND ((evaluat* OR effect* OR efficac* OR (follow* NEXT/1 up*) OR followup OR outcome* OR assesment*):ab,ti)

Supplement 2. Table S1: Intervention content of interventions (n=8)

Study	Control condition	Intervention condition	Cultural tailoring
McEachan et al. (2016)	Usual care. Access to and support form health professionals and support agencies delivered in a range of locations.	Twelve group sessions, six antenatal and six postnatal, consisting of verbal and written advice and promotion of positive parenting skills in recognition of healthy lifestyle behaviors that contribute to the prevention of childhood overweight/obesity (e.g., physical activity, healthy dietary behaviors). Intervention duration: 1 year.	Intervention was tailored to both White British and South Asian groups: - Use of community sources to develop and publicize the intervention. - Identification and address of barriers to access and participation. - Development of language sensitive communication strategies. - Consideration of cultural/religious values that promote or hinder behavioral change. - Recognition of degrees of ethnic identification. - Intervention development is informed by local practitioners with experience in delivering community based interventions to a range of ethnic groups.
Puder et al. (2011) Burgi et al. (2012)	School curriculum as usual (i.e., 45 minute physical activity lesson per week). Parents participated in one information and discussion evening.	Children were given physical activity and nutrition activity cards, promoting specific exercises to be done at home. Preschool teachers participated in two workshops to learn about the content and the practical aspects of the interventions. Parents participated in three interactive information and discussion evenings, and were given brochures and information leaflets. School curriculum changes included four 45 minute physical activity lessons per week, health education sessions, promotion of healthy snacks during recess and treats for anniversaries, exclusive offering of water and healthy food to the children by the preschool classes, and a Ballabeina games event. Adaption of the built environment in and around the preschool included the installation of fixed and mobile physical activity equipment. Intervention duration: 10 months (1 school year).	Intervention was tailored to a culturally heterogenic group: - Identification of norms and needs through pilot studies, focus groups, and expert meeting. - Written information provided in ten languages. - Recommendations on physical activity and nutrition were kept simple and short and contained many pictures.

Study	Control condition	Intervention condition	Cultural tailoring
Adab et al. (2014) Cezard et al. (2016)	School curriculum as usual.	Multicomponent intervention consisting of physical activities during school hours, encouragement of physical activity outside of school hours, attendance at local sports club, cooking courses for family members, information on local leisure opportunities, taster sessions for families, and community walking programs. Intervention duration: 1 year.	Intervention was tailored to South Asian communities: - Involvement of key stake holders drawn from South Asian communities in intervention development and identification of potential intervention barriers and opportunities.
Jansen et al. (2011)	School curriculum as usual (i.e., two physical education lessons per week by classroom teacher of physical education teacher, depending on school policy).	At the beginning of the school year, there was a health promotion gathering for parents and local sports clubs. Children received three physical educational lessons per week, guided by a physical education teacher. Additional sports and play activities were organized outside school hours (attendance voluntary). Children also received classroom education comprising of three main lessons on healthy nutrition, active living, and healthy lifestyle choices. Local sports clubs were involved in the intervention by providing some of the physical education lessons and sports activities outside school hours. Intervention duration: 10 months (1 school year).	No information provided on cultural tailoring. Similarly, in design article no specific information provided.
Muckelbauer et al. (2010)	School curriculum as usual.	Installation of one or two water fountains with free access to cooled plain or carbonated water. School curriculum changes included four 45-minute lessons on water losses, water needs of the body, and on the water circuit in nature (led by classroom teachers). Lessons were not culture-specific adapted. Intervention duration: 10 months (1 school year).	No information provided on cultural tailoring.
de Meij et al. (2011) van Stralen et al. (2012)	School curriculum as usual.	Children and their parents were provided with personal workbooks including assignments to perform in class and at home. Parents were offered information meetings, courses, and sports activities. School staff received instruction books. Accessible school sports activities were offered on a daily basis ("school sports clubs"). Children could join the club during out-of-school hours. Furthermore, children were offered recurrent breaks for physical activity, relaxation exercises, and posture exercise during regular lessons. Intervention duration: 9 months (1 school year).	No information provided on cultural tailoring. According to the design article, parental information was provided in parents' own language when necessary.

Study	Control condition	Intervention condition	Cultural tailoring
Van de Gaar et al. (2014)	School curriculum as usual. This includes the regular health promotion programme 'Enjoy Being Fit!'.	Use of promotion material and water promoting activities (e.g., pimp up your water bottle, pimp up your water jug). Free water was provided at school during the day and water breaks during physical education lessons offered. Children furthermore received special education water lessons and fun games. Parents were involved in the water promoting activities and received water education. Intervention duration: 14 months.	Intervention was tailored to Moroccan and Turkish groups: - Intervention Mapping. - Social Marketing techniques.
Eyre et al. (2016)	School curriculum as usual.	Children undertook a school-based pedometer challenge linked to the curriculum that required children to walk virtually form school to the coast (42 miles per week). Children were furthermore taught to skip and provided with a personal skipping rope. Children were also able to attend weekly afterschool activity sessions. Changes were made to the curriculum to include health education lessons. Intervention duration: 6 weeks.	No information provided on cultural tailoring.

Supplement 3.

Table S2: Quality assessment of randomized controlled trials (n=1)*

Criteria	McEachan et al. (2016)
Selection bias 1. Random sequence generation 2. Allocation concealment	*Low risk* 1. Minimization algorithm incorporating a random element 2. Randomization occurred immediately after baseline assessment using a secure centralized telephone based service
Performance bias 1. Blinding of participants and personnel	*Unclear risk* 1. No, not possible to blind participants or those delivering the intervention
Detection bias 1. Blinding of outcome assessment	*Low risk* 1. Yes, but only partially successful
Attrition bias (n follow up/n baseline)	*Low risk* At 6 months: 83/120 = 69% At 12 months: 85/120 = 71% Similar number and reasons for loss to follow-up between treatment arms
Reporting bias 1. Study design published	*Low risk* 1. Yes
Other bias: Baseline imbalance 1. Baseline differences present 2. Adjustment for potential confounders	*Unclear risk* 1. Yes 2. Partly
Other bias: Outcome assessment 1. Self-reported or objectively measured data 2. Validity and reliability of assessment tools reported	*Unclear risk* 1. Combination of objectively measured data and self-report data 2. Validated objective measures where used when appropriate and available. When no validated tools were available, study specific measures were used

* Quality assessment based on Cochrane criteria.

Table S3: Quality assessment of cluster randomized controlled trials (n=3)*

Criteria	Puder et al. (2011) Burgi et al. (2012)	Jansen et al. (2010)	Van de Gaar et al. (2014)
Selection bias 1. Random sequence generation 2. Allocation concealment 3. Individuals recruited after cluster randomization	*Low risk* 1. Opaque envelopes 2. Randomization at once 3. No	*Low risk* 1. Coin toss 2. Sequential coin toss 3. No	*Low risk* 1. Coin toss 2. Sequential coin toss 3. No
Performance bias 1. Blinding of participants and personnel	*Unclear risk* 1. No, not possible to blind participants or those delivering the intervention	*Unclear risk* 1. No, not possible to blind participants or those delivering the intervention	*Unclear risk* 1. No, not possible to blind participants or those delivering the intervention
Detection bias 1. Blinding of outcome assessment	*Low risk* 1. Yes	*Unclear risk* 1. No	*Unclear risk* 1. No
Attrition bias 1. Clusters 2. Individuals (n follow up/n baseline)	*Low risk* 1. 40/40= 100% 2. 626/652= 96%	*Low risk* 1. 20/20= 100% 2. 2416/2622= 92%	*Low risk* 1. 4/4= 100% 2. 1068/1175=91%
Reporting bias 1. Study design published	*Low risk* 1. Yes	*Low risk* 1. Yes	*Unclear risk* 1. No
Other bias: Baseline imbalance 1. Pair matched randomization 2. Baseline differences present 3. Adjustment for potential confounders	*Low risk* 1. 1:1 randomization 2. Yes 3. Yes	*Low risk* 1. Yes 2. Yes 3. Yes	*Low risk* 1. Yes 2. Yes 3. Yes
Other bias: Outcome assessment 1. Self-reported or objectively measured data 2. Validity and reliability of assessment tools reported	*Unclear risk* 1. Lifestyle behaviors measured by questionnaire (parent). Physical activity additionally objectively measured. Anthropometric variables objectively measured 2. Yes (satisfactory)	*Low risk* 1. Anthropometric variables objectively measured 2. Yes (satisfactory)	*Unclear risk* 1. Dietary behaviors assessed by questionnaire (child, parent) and observation (school) 2. No
Other bias: Statistical analysis 1. Taking clustering into account	*Low risk* 1. Yes	*Low risk* 1. Yes	*Low risk* 1. No (too few clusters)

* Quality assessment based on Cochrane criteria.

Table S4: Quality assessment of cluster controlled trials (n=4)*

Criteria	Adab et al. (2014) Cezard et al. (2016)	Muckelbauer et al. (2010)	de Meij et al. (2011) van Stralen et al. (2012)	Eyre et al. (2016)
Performance bias *1. Blinding of* participants and personnel	*Unclear risk* 1. No, not possible to blind participants or those delivering the intervention	*Unclear risk* 1. No, not possible to blind participants or those delivering the intervention	*Unclear risk* 1. No, not possible to blind participants or those delivering the intervention	*Unclear risk* 1. No, not possible to blind participants or those delivering the intervention
Detection bias 1. Blinding of outcome assessment	*Unclear risk* 1. NI	*Unclear risk* 1. NI	*Unclear risk* 1. No	*Unclear risk* NI
Attrition bias 1. Clusters 2. Individuals (n follow up/n baseline)	*Low risk* 1. 8/8= 100% 2. 488/574= 85%	*Low risk* 1. 32/33= 97% 2. 1306/1407= 93%	*Low risk* 1.19/19= 100% 2. At 8 months 2363/2848= 83% At 20 months 1824/2848= 64% Most common reasons for dropout were absence due to illness or transfer to another school	*Unclear risk* 1. 6/6= 100% 2. 85/134= 63%
Reporting bias 1. Study design published	*Low risk* 1. Yes	*Low risk* 1. No	*Low risk* 1. Yes	*Low risk* 1. No
Other bias: Baseline imbalance 1. Pair matched controlled 2. Baseline differences present 3. Adjustment for potential confounders	*Low risk* 1. Yes 2. Yes 3. Yes	*Low risk* 1. Yes 2. Yes 3. Yes	*Low risk* 1. Yes 2. Yes 3. Yes	*Unclear risk* 1. Yes, intervention group and control group from different school years from the same school. Potential for spill-over effect between intervention and control group 2. No 3. Partly

Criteria	Adab et al. (2014) Cezard et al. (2016)	Muckelbauer et al. (2010)	de Meij et al. (2011) van Stralen et al. (2012)	Eyre et al. (2016)
Other bias: Outcome assessment 1. Self-reported or objectively measured data 2. Validity and reliability of assessment tools reported	*Low risk* 1. Anthropometric variables and physical activity objectively measured 2. Yes (satisfactory)	*Unclear risk* 1. Anthropometric variables objectively measured. Dietary behaviors measured by questionnaire (child) 2. Yes (satisfactory)	*Unclear risk* 1. Sports participation measured by interview. Other lifestyle behaviors measured by questionnaire (child). Physical activity additionally objectively measured. Anthropometric variables objectively measured 2. No	*Low risk* 1. Anthropometric variables and physical activity objectively measured 2. Yes
Other bias: Statistical analysis 1. Taking clustering into account	*Low risk* 1. No (too few clusters)	*Low risk* 1. Yes	*Low risk* 1. Yes	*Unclear risk* 1. No (too few clusters)

* Quality assessment based on Cochrane criteria. NI= no information provided.

7

The development of the 'Water Campaign': combining Social Marketing and Intervention Mapping

Journal of Social Marketing, 2016, 6 (4), 318-334

L.M.G. Blanchette & V.M. van de Gaar
H. Raat
J. French
W. Jansen

Abstract

Background: This paper presents a description of the development and implementation of a combined school- and community-based intervention for the prevention of overweight among children, using the combined methods of Social Marketing (SMk) and Intervention Mapping (IM).

Methods: The SMk total process planning (TPP) framework was used, a simple but robust framework that consists of five stages: scoping, development, implementation, evaluation and follow-up. In addition IM tools were embedded in the development stage to strengthen the development element of the Campaign.

Results: The use of the SMk TPP framework led to the selection of one specific target segment and behaviour. IM tools helped to select the most important and modifiable determinants and behaviours in the target segment, as well as to select and appropriately apply theoretical methods for influencing determinant and behaviour change. The resulting 'Water Campaign' was aimed at Moroccan and Turkish mothers and their 6-12-year-old-children (target segment).

This intervention addresses the consumption of sugar-sweetened beverages through the promotion of tap water drinking (target behaviour). The systematic involvement of key stakeholders resulted in capacity-building and co-creation.

Conclusions: A key finding of the present work is that the SMk TPP framework and IM tools can be successfully combined in intervention development, helping to develop enhanced interventions. Combining these methods led to a theory-based and client-oriented intervention, which was directed at multiple ecological levels and which systematically involved key stakeholders. With this detailed description of the intervention development, this paper aims to assist other researchers and practitioners in their quest to develop better interventions.

Background

Overweight and obesity in children is linked to numerous adverse health outcomes later in life, making the high worldwide prevalence of childhood overweight a major public health concern [1-3]. There is a call for integrated, effective and sustainable interventions at multiple ecological levels [4-7].

In response to the high prevalence of overweight amongst children, the Enjoy Being Fit! (EBF) primary school programme was implemented in Rotterdam (the Netherlands) in 2005 [8]. The programme was a success both regarding uptake by the stakeholders and impact on health outcomes and is currently run in approximately 50% of primary schools in the Rotterdam area.

In 2010, a pilot intervention based on Social Marketing (SMk) was developed to improve the positive effects of the existing EBF-programme. This pilot focused on parents' involvement in encouraging positive behaviour change with regard to their children's energy balance-related behaviours. Subsequently, the aim was to increase community involvement of stakeholders, given combined school- and community-based interventions are more effective and sustainable than either school- or community-based interventions alone [9].

SMk has led to successful childhood overweight prevention interventions [10-14]. A major strength of SMk is its 'client-oriented' focus, resulting not only in tailored interventions, but also in improved intervention reception and acceptance [15-17]. In recent years, SMk methods have integrated the involvement of key stakeholders at various ecological levels [16, 18]. This is in line with best practice principles for community-based interventions [19].

Interventions that make extensive use of theory tend to have larger and more sustainable effects on behaviour than interventions that make less or no use of theory [20, 21]. However, SMk methods currently provide limited guidance about how to embed the use of theories, models and theoretical behaviour change methods [7, 22]. In addition, in a recent review analysing the use of different theories and models in SMk health interventions, it is argued that too often no report is being made about which theory is being used or how it is being used [22]. This lack of detailed guidance may lead to less adequate intervention design,

which in turn may lead to interventions which are not as effective as they could be. General health promotion methods such as Intervention Mapping (IM) are frequently suggested when developing interventions because they can easily be used in combination with other methods [17]. IM is known to produce encouraging results with regard to health behaviour change interventions, including interventions that address childhood overweight [23, 24]. The strength of IM is its extensive and structured use of behavioural and social science theories, as well as its provision of detailed tools to understand and influence behaviour [25]. The city of Rotterdam therefore used IM tools in combination with SMk to develop a combined school- and community-based intervention for the prevention of overweight among children.

This paper presents a description of the development and implementation of this intervention, called the 'Water Campaign'; a pilot intervention aimed at reducing children's consumption of sugar-sweetened beverages (SSB) by promoting the intake of water. The effectiveness study of the 'Water Campaign' showed positive intervention effects [26]. This detailed description aims to assist other researchers in their quest to develop better interventions.

Methods

The pilot intervention was to be implemented in two disadvantaged neighbourhoods in Rotterdam (the Netherlands). The Medical and Ethical Review Committee of the Erasmus Medical Centre issued a 'declaration of no objection' (i.e., formal waver) for this study (reference number MEC-2011-183).

IM tools were integrated and embedded in the SMk total process planning (TPP) framework. This TPP framework is a simple but robust framework to support effective intervention planning, development and delivery [16]. It was expected that the combination of the TPP framework with IM tools would allow the team to take full advantage of the strengths of each of these methods.

The TPP framework consists of five stages: scoping, development, implementation, evaluation and follow-up [16]. In this paper we address the first four stages.

Scoping stage

The scoping stage is an iterative process which aims to build an in-depth understanding of the issue at stake and of the lives and behaviours of the target population, as well as identifying relevant stakeholders, barriers to change and community assets that can assist in bringing about positive change. Additionally, scoping involves gathering evidence about what types of intervention work. The scoping stage results in the choice of target behaviours and target segments.

Development stage

The objectives of this stage are three-fold: to develop a tailored intervention based on previously gathered information and selected behavioural goals; to pre-test the intervention within the target segment; and to refine the work if required. In addition, involving key stakeholders during the scoping and development stages provides valuable expertise, ensures stakeholders buy-in and helps to turn potential opposition into allies.

IM tools were embedded in this stage. IM tools helped to select the most important and modifiable determinants for the target segments, as well as to select and appropriately apply theoretical methods for influencing determinant change [25].

Implementation stage

The objectives of this stage are to launch, implement, manage, monitor and, if necessary, adjust the intervention based on evaluation and feedback.

Evaluation stage

This stage aims to determine the extent to which the intervention objectives have been reached; what worked well, what did not, and why; whether there were any unintended outcomes, both positive and or negative; and finally, what can be learned from this project to improve practice and other projects.

Results

The results are described per stage of the TPP framework.

Scoping stage

A wide range of research was carried out including: analysis of local epidemiologic data, selection of a behavioural model, information gathering about leisure activities, health, values and norms regarding upbringing of children, behaviour (change), and community groups. Additionally, interviews and focus groups were conducted with the target audience to verify research findings and to gather more in-depth information on the potential target segments and their behaviours. Topics included themes like: daily activities and issues that matter to parents and children, differences/similarities to citizens of Dutch descent, family roles and parenting practices, what is a good mother/father, and lessons learned from attempts to change lifestyle.

The most important findings were: 1) children of Moroccan and Turkish descent together made up almost 60% of the 6-12-year-old-children in Rotterdam who are overweight, while children from Dutch origin made up less than 10% of this group [8, 27]; 2) citizens of Dutch descent of low socio-economic status are less receptive than other groups to information and interventions provided by the government and health professionals [28, 29]); 3) when encouraging positive behaviour change with regard to their children's energy balance-related behaviours, more focus should be on parental involvement [30, 31]; 4) more specifically, in migrant families it is the mother who is – in practice – the most closely and directly involved in the upbringing and care of the children [32, 33]; 5) the selection of the Environmental Research Framework for Weight Gain Prevention (EnRG-framework) as behaviour model [34]; 6) the identification of 21 potential target behaviours in children through literature [35-37].

In addition to target audience interviews, 15 professionals were interviewed (e.g., teachers, religious leaders, and welfare workers) to inform the design of the intervention. The earlier findings were confirmed and the choice for mothers of Moroccan and Turkish descent as the potential target segment was supported [27].

Four focus groups (n=24) were conducted in which individuals from the potential target segments participated. The first two focus groups showed differences in parenting practices within this segment of mothers [27]. A distinction could be made between mothers who immigrated to the Netherlands either during adolescence or as an adult (≥12-year-old, hereafter named 'traditional mothers' and estimated to represent approximately 70% of the Moroccan and Turkish mothers) and mothers who either had been born in or had immigrated to the Netherlands at a young age (<12-year-old, so who attended primary school in the Netherlands, hereafter named 'modern mothers').

The other focus groups, one with 'traditional mothers' and one with 'modern mothers', revealed that both groups of mothers appear to be deeply motivated to be 'good mothers' (being a kind, loving, and good caregiver and educator) in addition to having aspirations for a good future for their children [27]. Relevant differentiating beliefs between the two types of mothers are that 'traditional mothers' appear to see being overweight as a sign of prosperity that can provide the individual with reserves in the event of ill health. While 'traditional mothers' have lower levels of self-efficacy with regard to their parenting practice – 'modern mothers' tend to be more confident – some are in search of practical tips and skills with regard to this aspect.

Using the gathered information, the following primary target segment was defined as: Moroccan and Turkish mothers of 6-12-year-old-children (both 'modern' and 'traditional mothers').

For the selection of the target behaviour, we scored the potential target behaviours in children (n=21) on their suitability for the intervention based on what was known on the prevalence of these behaviours among the children in Rotterdam [27, 35-37]. Given the knowledge that was gained about the target segment, decreasing the child's SSB consumption was considered to be the most suitable potential behavioural target for further intervention development. The professionals verified our findings and acknowledged their shared observation of the widespread high daily consumption of SSB in children (4-7 SSB servings per day) [27]. In addition, the professionals claimed to have achieved encouraging results in decreasing consumption of SSB in practice, making this behaviour the most promising potential target behaviour. The widespread high

consumption of SSB (35% >2 SSB servings per day) was further confirmed through analysis of local epidemiological data [27].

During the focus groups, participants discussed the benefits and costs of this potential target behaviour. For example, participants identified "my child finds SSB delicious" as a benefit and "SSB is bad for the teeth" as a cost of the target behaviour. The costs and benefits of the desirable behaviour (no SSB) were also discussed with the target groups. Examples of answers provided are: "my child is less busy and excited and can concentrate better" (benefit) and "I am a strict/severe mother if I give less SSB" (cost). These insights provided relevant information as to which determinants influenced the behaviour of the mothers and children and to what extent.

Given the information that we had gained, the target behaviour for children was therefore 'decreasing consumption of SSB'. The desired behaviour was then specified as 'drinking at least two servings of tap water per day'. There were several reasons for selecting this specific behaviour. First, interventions known to be effective in promoting water drinking have also shown results in decreasing consumption of SSB [38-41]. The literature indicates that working with a positive message often leads to positive results [42]. A negative message, i.e., the advice to consume less or no SSB, could discourage or even provoke the opposite behaviour. Another reason for selecting this behaviour target was the necessity to keep the objective of the intervention as simple and specific as possible. There was a perceived need to avoid complicated advice concerning total recommended daily amounts of liquids, as well as any advice about the consumption of beverages containing artificial sweetener. Finally, the fact that tap water is easily available and accessible, at no financial cost, was yet another argument in favour of a focus on the promotion of drinking tap water. The target behaviour goal for mothers was logically derived from the target behaviour goal for children, namely 'effectively serving tap water to their children (6-12-year-old) at least twice a day'.

Identification of relevant stakeholders

Two schools that had been selected for the evaluation of the 'Water Campaign' were formally involved in the project development and implementation as partners. In addition, a neighbourhood analysis served to identify additional relevant stakeholders: the water

supply company, local health professionals, community and welfare organizations were also engaged in developing and delivering the intervention.

Development stage

Mobilization and involvement of stakeholders

For the 'Water Campaign', school partners (like physical education teachers) were closely and directly involved in the development, pre-testing, planning and delivery of the intervention's components which were to be implemented at school. Other stakeholders, in particular the local health professionals and community organizations, were encouraged to co-create and deliver the 'Water Campaign' intervention's components where applicable. Throughout the process, the project team made sure that the input of partners and stakeholders was acknowledged.

Intervention development

In addition to the mobilization and involvement of the stakeholders, the development stage comprised three other elements: 1) marketing mix analysis: 2) behaviour determinants analysis (i.e., IM): and 3) intervention development.

1. The marketing mix analysis

The starting point for the development of the intervention is to understand what it is that will assist individuals in the target segment in adopting or sustaining health behaviours. This involves positively and effectively connecting the recommended target behaviour to the reality experienced by these individuals (day-to-day life, priorities, challenges) and their deep motives (their dreams and what they value). Based on the findings from the scoping stage, a marketing mix analysis was performed. To begin with, we clarified the underlying benefits that individuals in the target segment obtain by performing the target behaviour. The most compelling benefits became part of the tailored 'exchange' proposition. This proposition is a working proposition that serves to clearly establish how the desired behaviour of the target segment will consistently be framed and connected (i.e., positioned) to the deep motives of the target segment. All subsequently developed components of the intervention would have to conform to this exchange proposition. In this study, the tailored exchange proposition for the target segment was: the mother sees giving water to her children at least twice a day as an important part of being a good

mother and a prerequisite for the development of her child. This connected the target behaviour to the mothers' deep motive to 'be a good mother' (being a kind, loving, and good caregiver/educator) and to their aspirations for a good future for their children.

Then, the following elements were clarified: the real or perceived 'costs' and barriers that the target segment faced when changing to the desired behaviour; the features and characteristics which could make the intervention attractive for the target segment (e.g., preferred types of activities/resources); the 'places' where the various intervention components should be made available; and the 'promotion', i.e., how the various intervention components should be made known to the target segment.

2. The behaviour determinants analysis

In order to provide a strong theoretical basis for the development of the intervention, the EnRG-framework and IM were combined with the gathered knowledge and information. The team used the EnRG-framework – an integrated behaviour model combining an ecological perspective and the Theory of Planned behaviour – to help obtain a comprehensive overview of possible determinants of the selected target behaviour. Costs (i.e., price) and benefits of the desired and undesired behaviours identified earlier were integrated into this determinant analysis. IM tools were applied to score the importance and modifiability of the determinants for the target segment based on previously gained information. The analysis of these scores resulted in the selection of the most relevant and promising determinants. Thereafter, appropriate theoretical methods – i.e., general techniques or processes for influencing changes in determinants of behaviours of the target segment – were identified for each of the determinants selected. This was done using the IM summary of theoretical methods [25]. Herein it was important that the parameters of the method, i.e., the conditions under which the methods are shown to be effective, were carefully taken into account. Additional information about the determinant analysis can be obtained via the authors.

3. Campaign Interventions development

A 'brand' was developed as an overarching marketing concept for the entire Campaign [43]. For the development of the actual intervention, the types of activities and resources preferred by the target segment (e.g., group activities, magazines), served as the starting point. The specific 'content' of the preferred activities and resources was then further

developed through the embedding of various combinations of previously selected determinants and their associated theoretical methods. This provided sound theory-informed content for the preferred activities and resources. For each intervention component that had been developed, the theoretical parameters of the selected methods had to be addressed. The other elements of the marketing mix analysis such as 'price', 'place' and 'promotion' were also taken into account in the design of each of the intervention components, as was conformity to the exchange proposition.

Intervention components for mothers

Information from the focus groups revealed that mothers enjoy social contacts with other mothers in groups, in a convivial and cosy atmosphere. Taking 'group activities' for the mothers as a preferred form of intervention design, the specific 'content' was then further developed by integrating the previously selected 'important and modifiable' determinants and their associated theoretical methods. For example, knowledge (through the theoretical method active learning), attitude (through persuasive communication), skills (through modelling), self-efficacy (through goal setting) and subjective norm (through mobilizing social support) were combined together and formed the 'pimp up my water jug' workshop.

Intervention components for children

Given that for the 'traditional mothers' the determinant analysis showed a 'modifiability' that was generally lower than expected (and considering that in Rotterdam approximately 70% of the Moroccan and Turkish mothers are 'traditional mothers' [27]), it was concluded that the intervention would also need to be directly aimed at children. In this way the mothers and children would 'reinforce' each other in their 'family system' [34].

A similar process was used for the development of intervention components for children. School interventions were given preference above interventions in other settings to ensure and contribute to optimal reach and implementation fidelity. Examples of activities are the 'water lessons at school'.

Additional intervention activities

Water breaks during physical education lessons were introduced, targeting both parents and children. These breaks were facilitated and reinforced by giving the children a free water bottle and sending a letter to parents asking them to fill up the children's water

bottles at home at least three times a week for use during these physical education lessons. A full-colour, glossy magazine about water was specifically developed and produced. This was a direct result of the feedback provided by mothers during the pre-testing of the 'pimp my water jug' workshop, in which mothers mentioned that they would like to have written information. Promotional materials such as posters (see Figure 1) were offered to partners and local stakeholders, along with tips on how to promote tap water drinking.

Figure 1: The 'Water Campaign' posters

Several stakeholders, inspired by the SMk principles and newly gained knowledge about the target segment, adapted some of their own interventions; some even created and implemented their own tap water promoting activities. For instance by providing free water bottles during their summer activities for children. Another example of such an initiative was a family card game developed by the water supply company.

Implementation stage

The 'Water Campaign' was launched in April 2010. In the following 15 months, all 14 intervention components were implemented (Table 1). Though the 'Water Campaign' was developed based on information of the target segment, the intervention itself was available for all children and families living in the two intervention neighbourhoods. During the summer months of 2010, several stakeholders hosted several 'tap water drinking promoting activities' for children – on their own initiative. At the beginning of the subsequent school year (2010/2011), the intervention components aimed at habitual

behaviour were incorporated into school policies and practices; they were later reinforced through other activities. Various actors were responsible for the implementation of intervention components, depending on the time, place and for whom the activities were intended.

Evaluation stage

To test the effectiveness of the intervention a controlled trial was set up [26]. Intervention and control schools both took part in the regular EBF-programme, the intervention schools additionally took part in the 'Water Campaign'. The outcome measures used were the reported child's consumption of SSB by mothers, by children themselves, and the observed child's SSB consumption at schools. Positive intervention effects were found, which gave a good indication that the 'Water Campaign' was successful in reducing children's consumption of SSB. Details about the effect study are reported elsewhere [26].

A process evaluation was conducted to evaluate implementation fidelity and acceptability to providers and target segment, as well as to assess reach and participation of both children and mothers. An anonymous online stakeholders' survey was conducted among stakeholders (n=42) during the second part of the development and implementation year. This survey explored the stakeholders' motivations for wanting to collaborate (or not), the collaboration processes itself, as well as the results and consequences of collaboration. Results will be reported elsewhere.

Table 1: 'Water Campaign' overview

Timeline	Intervention components	For whom?	By who delivered?	Location?
April 2010	Kick-off 'Water Campaign'	Children & parents	Sport city councilor and school director for parents; local sport role model for children	School
April 2010	Promotion materials and information for local professionals[1]	Children & parents	Local professionals	School, local professionals and community organizations[2]
June 2010 – June 2011	Pimp up my water jug	Parents	Project staff	School and community organizations
June 2010	Pimp up my water bottle	Children	Project staff	School
July – August 2010	Free water bottles for children during summer activities	Children	Welfare organizations[3]	Community organizations
October 2010 – June 2011	Water drinking during lessons at school	Children	Teacher	School
October 2010 – June 2011	Water break during physical education lessons and free refillable bottles	Children & parents	Physical education teacher	School
November 2010	'Fill your water bottle here'-stickers	Children (& parents)	Project staff and sport organizations	Sport facilities
March – April 2011	Water week, consisting of: a) Kick-off/water show b) Water week lessons c) Fun games/card game d) Storytelling/theatre e) Glossy water magazine f) Water ambassadors	 a) Children & parents b) Children c) Children & parents d) Parents e) Parents f) Parents	 a) Children's local sport role model b) Teacher c) Teacher d) Theatre group e) Home-school liaison officers f) School director	School

[1] Local professionals: general practitioners, dieticians, dentists, physiotherapists, lifestyle advisors, youth health services
[2] Community organizations: local Turkish associations, local women associations, local migrant associations
[3] Welfare organizations: community development workers, youth work organizations

Discussion

This paper presents a detailed description of the development of the 'Water Campaign' with the aim of helping to advance future intervention development. During the development of this campaign, the various stages of the TPP framework were processed, the target segment and the target behaviour were then selected and the marketing mix was used to develop intervention components that addressed the most important and modifiable behavioural determinants.

This paper describes how IM tools were embedded in the TPP framework and illustrates how this combination can be operationalized to develop interventions. The resulting integration of the strengths of both methods may well improve the effectiveness and sustainability of the resulting intervention and allows integration of various ecological levels.

According to French and colleagues, to succeed in implementing effective strategies, we need to focus on a 'value to user' approach [16]. In terms of methods, the TPP framework offers detailed guidance and techniques leading to client orientation, as illustrated in this article.

The findings from the extensive iterative scoping stage led to the selection of one specific target segment. This focus on one fairly homogenous target segment with similar needs, beliefs, attitudes and behaviours meant that the intervention components were better matched to the target segment's specific perceived needs (thus going beyond selection primarily based on socio-demographic characteristics). By doing so, it becomes easier for people in the target segment to adopt and sustain positive behaviours. Therefore, the 'Water Campaign' may have been more effective than when designed for a more heterogeneous target group [13].

The scoping stage provided a deeper understanding of the problem at hand as well as of the lives of the target segment as a whole and what they value. These in-depth insights guided the selection of one specific behavioural goal at a time, making it easier to conceive, develop and implement a realistic and achievable intervention for the specific target segment. It also meant that there was a precise way of measuring progress and

intervention's impact on behaviour. This is in line with for instance the ensemble prévenons l'obésité des enfants, meaning together let's prevent childhood overweight (EPODE) approach, where the focus is always limited to one specific theme at a time [15]. However, it contrasts with findings of several systematic reviews in the field that recommend addressing complex problems such as childhood overweight by intervening on multiple energy balance-related behaviours [44, 45]. The choice to focus on one specific behavioural goal is inherent to the choice to use SMk. This one specific behaviour was however selected and substantiated on the basis of an extensive scoping stage.

The marketing mix analysis enabled clarification of the most compelling motives of the target segment, the benefits and costs to them of performing the desired behaviour and target segments' preferences [16]. On the basis of this knowledge, marketing techniques allowed the project team to connect the target behaviour, the value system and the deep motives of the target segment, thus contributing to a tailored intervention [13, 17].

Having recognized the importance of theory-informed intervention development, the EnRG-framework contributed to a more comprehensive understanding of the behaviour of the target segment and provided a clearer picture of potential determinants. IM tools allowed to select those determinants in our target segment that were the most important and most modifiable. Furthermore, they enabled the project team to first consider and select appropriate theoretical methods for influencing changes in determinants of behaviour before proceeding to the development of specific interventions.

The fact that key stakeholders at various ecological levels were systematically identified and involved in the campaign resulted in bi-directional sharing of knowledge and expertise, co-creation and active participation among partners and stakeholders [16]. These findings are supported by a study that found that the involvement of stakeholders in programme development and implementation appears to increase programme receptivity and acceptance [4]. Furthermore, the successful EPODE approach also includes as part of its working principles the mobilization and involvement of stakeholders in combination with capacity-building strategies [15].

The team's choice for the target behaviour 'reducing children's SSB consumption' was supported by studies in the literature [1-3, 35-37] and local epidemiological data [27]. This target behaviour was modified into the specific behaviour 'drinking at least two servings of

water per day'. Although the literature supports both the choice for the promotion of water [38-41], as well as the choice for a positive message [42], one could argue that the specification of 'two servings per day' is somewhat arbitrary. However, this message was chosen because pre-testing within the target segment (mothers) indicated that the advice of consuming at least two servings of water per day seemed to be a realistic, acceptable and achievable target behaviour.

The follow-up and sustainability of the 'Water Campaign' depended on the results of the evaluation stage. Given the successful behavioural change, several intervention components were implemented on a wider scale (in 90 schools throughout the city of Rotterdam). New collaborations were set up with local sport clubs and community organizations participated more actively to promote the intake of water among children in various ways. The continuation of the intervention, the process and its effects on behaviour is monitored and evaluated by the local Municipal Health Service. Evaluation of the effects on the longer term is necessary for intervention sustainability. Subsequently, the 'Water Campaign' was disseminated nation-wide, reaching more than 70 cities across the Netherlands.

Lessons Learned

Throughout the process of applying SMk, some of the lessons learned went beyond intervention development alone. Two issues stand out in this respect. The first issue is the sharing of knowledge about the principles and application of SMk and the insights about the target segments and behaviours (capacity building); Secondly, the co-creation with partners which resulted in considerable enthusiasm, active participation, ownership, and embedding of the 'Water Campaign' among partners. Some partners used the new knowledge and skills in the context of their own core business, thereby multiplying the benefits not only for the target segment but also, in this case, for local government.

SMk further provided the project team with a shared 'marketing language' that could be used when cooperating with private partners. On the other side, some tensions between the political context and the consequences of applying SMk were noticeable. The choice of a specific behaviour for a specific segment may not always appear to match the broader government mandate and policies. The transferability across policy fields of the

knowledge and skills gained can, if well organized, form a strong argument in favour of SMk in combination with IM.

The project team was made up of experienced people from research, practice and policy as well as private (marketing) partners, thereby providing a variety of skills and knowledge. Furthermore, it is noteworthy that the 'Water Campaign' was developed in a local context with limited time and resources. The scoping and development phases in particular took more time than anticipated. This was partly due to the project team's lack of experience in specifically combining SMk and IM tools. Planners of future health interventions that intend to combine SMk and IM are advised to ensure that various team members have experience with using either one or both of these methods. They should also ensure that team members and commissioning parties are committed to the combined approach, and are willing to invest time and effort into understanding each other's methodological paradigm and methods.

A number of limitations should be mentioned. A first limitation is that we chose the TPP framework of French et al, and not any other SMk development method [46]. A second limitation is that only in the development stage the IM method was partly used. Future intervention development studies should provide additional insight into the value of combining complementary methods such as SMk and IM, for instance by expanding the integration of these methods.

Conclusions

This paper describes the development of an intervention through the combined application of SMk and IM tools. This led to a theory-based and client-oriented intervention for the prevention of overweight among children. The intervention was school- and community-based, directed at multiple ecological levels and systematically involved stakeholders. Future research should focus on whether this combination of complementary methods leads to the development of effective interventions.

References

1. Hu FB. Resolved: there is sufficient scientific evidence that decreasing sugar-sweetened beverage consumption will reduce the prevalence of obesity and obesity-related diseases. *Obes Rev* 2013; **14**(8)**:** 606-19.
2. de Ruyter JC, Olthof MR, Seidell JC, Katan MB. A trial of sugar-free or sugar-sweetened beverages and body weight in children. *N Engl J Med* 2012; **367**(15)**:** 1397-406.
3. Ebbeling CB, Feldman HA, Chomitz VR, Antonelli TA, Gortmaker SL, Osganian SK *et al.* A randomized trial of sugar-sweetened beverages and adolescent body weight. *N Engl J Med* 2012; **367**(15)**:** 1407-16.
4. Flynn MA, McNeil DA, Maloff B, Mutasingwa D, Wu M, Ford C *et al.* Reducing obesity and related chronic disease risk in children and youth: a synthesis of evidence with 'best practice' recommendations. *Obes Rev* 2006; **7 Suppl 1:** 7-66.
5. Fagg J, Chadwick P, Cole TJ, Cummins S, Goldstein H, Lewis H *et al.* From trial to population: a study of a family-based community intervention for childhood overweight implemented at scale. *Int J Obes* 2014.
6. Braun KL, Nigg CR, Fialkowski MK, Butel J, Hollyer JR, Barber LR *et al.* Using the ANGELO Model To Develop the Children's Healthy Living Program Multilevel Intervention To Promote Obesity Preventing Behaviors for Young Children in the US-Affiliated Pacific Region. *Child Obes* 2014; **10**(6)**:** 474-81.
7. Van Koperen MT, Van der Kleij RM, Renders C, Crone M, Hendriks A-M, Jansen M *et al.* Design of CIAO, a research program to support the development of an integrated approach to prevent overweight and obesity in the Netherlands. *BMC Obesity* 2014; **1**(5).
8. Jansen W, Borsboom G, Meima A, Zwanenburg EJ, Mackenbach JP, Raat H *et al.* Effectiveness of a primary school-based intervention to reduce overweight. *Int J Pediatr Obes* 2011; **6**(2-2)**:** e70-7.
9. Bleich SN, Segal J, Wu Y, Wilson R, Wang Y. Systematic review of community-based childhood obesity prevention studies. *Pediatrics* 2013; **132**(1)**:** e201-10.
10. Government UK. Change 4 Life - One Year On. In: U.K. Government, 2010.
11. Evans WD, Christoffel KK, Necheles JW, Becker AB. Social marketing as a childhood obesity prevention strategy. *Obesity (Silver Spring)* 2010; **18 Suppl 1:** S23-6.
12. Huhman ME, Potter LD, Nolin MJ, Piesse A, Judkins DR, Banspach SW *et al.* The Influence of the VERB campaign on children's physical activity in 2002 to 2006. *Am J Public Health* 2010; **100**(4)**:** 638-45.
13. Stead M, Hastings G, McDermott L. The meaning, effectiveness and future of social marketing. *Obes Rev* 2007; **8 Suppl 1:** 189-93.
14. Mathews LB, Moodie MM, Simmons AM, Swinburn BA. The process evaluation of It's Your Move!, an Australian adolescent community-based obesity prevention project. *BMC Public Health* 2010; **10:** 448.

15. Borys JM, Le Bodo Y, Jebb SA, Seidell JC, Summerbell C, Richard D *et al.* EPODE approach for childhood obesity prevention: methods, progress and international development. *Obes Rev* 2012; **13**(4)**:** 299-315.

16. French J, Blair-Stevens C, McVey D, Merritt R. *Social Marketing and Public Health – Theory and Practice*, Oxford University Press: Oxford, 2010.

17. Griffiths J, Blair-Stevens C, Thorpe A. Social Marketing for health and specialised health promotion. In: *World Social Marketing*. Brighton & Hove City, England: National Social Marketing Centre, 2008.

18. Government US. CDCynergy, Social Marketing Edition - an interactive training and decision-support tool. In: U.S. Department of Health and Human Services CfDC, (ed): Centers for Disease Control, U.S. Government, 2014.

19. King L, Gill T, Allender S, Swinburn B. Best practice principles for community-based obesity prevention: development, content and application. *Obes Rev* 2011; **12**(5)**:** 329-38.

20. Brug J, Oenema A, Ferreira I. Theory, evidence and Intervention Mapping to improve behavior nutrition and physical activity interventions. *Int J Behav Nutr Phys Act* 2005; **2**(1)**:** 2.

21. Webb TL, Joseph J, Yardley L, Michie S. Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior techniques, and mode of delivery on efficacy. *Journal of Medical Internet Research* 2010; **12**(4).

22. Luca NR, Suggs LS. Theory and model use in social marketing health interventions. *J Health Commun* 2013; **18**(1)**:** 20-40.

23. Taylor NJ, Sahota P, Sargent J, Barber S, Loach J, Louch G *et al.* Using intervention mapping to develop a culturally appropriate intervention to prevent childhood obesity: the HAPPY (Healthy and Active Parenting Programme for Early Years) study. *Int J Behav Nutr Phys Act* 2013; **10:** 142.

24. Verbestel V, De Henauw S, Maes L, Haerens L, Marild S, Eiben G *et al.* Using the intervention mapping protocol to develop a community-based intervention for the prevention of childhood obesity in a multi-centre European project: the IDEFICS intervention. *Int J Behav Nutr Phys Act* 2011; **8:** 82.

25. Bartholomew LK, Parcel GS, Kok G, Gottlieb NH, Fernandez ME. *Planning health promotion programs, an intervention mapping approach*, 3rd edn Jossey-Bass: Francisco, California, 2011.

26. van de Gaar VM, Jansen W, van Grieken A, Borsboom G, Kremers S, Raat H. Effects of an intervention aimed at reducing the intake of sugar-sweetened beverages in primary school children: a controlled trial. *Int J Behav Nutr Phys Act* 2014; **11:** 98.

27. Krul C, Blanchette LMG, Jansen W, Meima B. City of Rotterdam: Scoping Enojy Being Fit Family Approach [Scoping Rapport: Gezinsaanpak Lekker Fit!]. In. Rotterdam, the Netherlands: City of Rotterdam, Department of Sports and Culture, 2012.

28. Heutink H, Van Diemen D, Elzenga M. "What do people with low and high SES themselfs have to say about healthy living?" [Wat hebben mesen met een lage en hoge(re) SES zelf te zeggen over gezond leven?]. *Tijdschrift Gezondheidswetenschappen* 2010; **88**(1).

29. Kooiker S, Van der Wijst L. *How to reach the low SES? Lessons from the study 'health beliefs'. [Hoe bereik je de lage SES? Lessen uit het onderzoek 'Gezondheidsopvattingen'.]*. Sociaal Plan Bureau, 2009.

30. Golley RK, Hendrie GA, Slater A, Corsini N. Interventions that involve parents to improve children's weight-related nutrition intake and activity patterns - what nutrition and activity targets and behaviour change techniques are associated with intervention effectiveness? *Obes Rev* 2011; **12**(2)**:** 114-30.

31. Sleddens EF, Gerards SM, Thijs C, de Vries NK, Kremers SP. General parenting, childhood overweight and obesity-inducing behaviors: a review. *Int J Pediatr Obes* 2011; **6**(2-2)**:** e12-27.

32. Pels T, Distelbrink M, Postma L. *"Parenting in the migration context; review of research on parenting in families of new Dutch"[Opvoeding in de migratiecontext; review van onderzoek naar de opvoeding in gezinnen van nieuwe Nederlanders]*. Verwey-Jonker Instituut: Utrecht, 2009.

33. Snoek H, Larsen J, Janssens J, Fransen G, Van Wijk E, Engels R *et al. Parental Involvement in Interventions on Childhood Obesity [Eindrapportage Fase I CIAO - Consortium Integrale Aanpak Overgewicht]. Edited by: Seidell JC, Raat H, Jansen M, Molleman G, Paulussen T.* ZonMw: The Hague, the Netherlands, 2010.

34. Kremers SP, de Bruijn GJ, Visscher TL, 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.

35. Barlow SE, Expert C. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics* 2007; **120 Suppl 4:** S164-92.

36. Swinburn BA, Caterson I, Seidell JC, James WP. Diet, nutrition and the prevention of excess weight gain and obesity. *Public Health Nutr* 2004; **7**(1A)**:** 123-46.

37. van der Horst K, Oenema A, Ferreira I, Wendel-Vos W, Giskes K, van Lenthe F *et al.* A systematic review of environmental correlates of obesity-related dietary behaviors in youth. *Health Educ Res* 2007; **22**(2)**:** 203-26.

38. Daniels MC, Popkin BM. Impact of water intake on energy intake and weight status: a systematic review. *Nutr Rev* 2010; **68**(9)**:** 505-21.

39. Muckelbauer R, Libuda L, Clausen K, Toschke AM, Reinehr T, Kersting M. Promotion and provision of drinking water in schools for overweight prevention: randomized, controlled cluster trial. *Pediatrics* 2009; **123**(4)**:** e661-7.

40. Sichieri R, Paula Trotte A, de Souza RA, Veiga GV. School randomised trial on prevention of excessive weight gain by discouraging students from drinking sodas. *Public Health Nutr* 2009; **12**(2)**:** 197-202.

41. Tate DF, Turner-McGrievy G, Lyons E, Stevens J, Erickson K, Polzien K *et al.* Replacing caloric beverages with water or diet beverages for weight loss in adults: main results of the Choose Healthy Options Consciously Everyday (CHOICE) randomized clinical trial. *Am J Clin Nutr* 2012; **95**(3)**:** 555-63.

42. Michale J. Positive And Negative Reinforcement, A Distinction That Is No Longer Necessary; Or A Better Way To Talk About Bad Things. *Journal of Organizational Behavior Management* 2004; **24:** 16.

43. PersuasiveBrands. Brand Definition. In, 2008.

44. Brown T, Summerbell C. Systematic review of school-based interventions that focus on changing dietary intake and physical activity levels to prevent childhood obesity: an update to the obesity guidance produced by the National Institute for Health and Clinical Excellence. *Obes Rev* 2009; **10**(1)**:** 110-41.

45. Kelishadi R, Azizi-Soleiman F. Controlling childhood obesity: A systematic review on strategies and challenges. *J Res Med Sci* 2014; **19**(10)**:** 993-1008.

46. Government US. *CDCynergy Lite, Social Marketing made simple: A guide for creating effective Social Marketing plans*. Centers for Disease Control, U.S. Government: http://www.cdc.gov/healthcommunication/pdf/cdcynergylite.pdf, 2014.

8

Effects of an intervention aimed at reducing the intake of sugar-sweetened beverages in primary school children: a controlled trial

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Abstract

Background: Since sugar-sweetened beverages (SSB) may contribute to the development of overweight in children, effective interventions to reduce their consumption are needed. Here we evaluated the effect of a combined school- and community-based intervention aimed at reducing children's SSB consumption by promoting the intake of water. Favourable intervention effects on children's SSB consumption were hypothesized.

Methods: In 2011-2012, a controlled trial was conducted among four primary schools, comprising 1288 children aged 6 to 12 years old who lived in multi-ethnic, disadvantaged neighbourhoods in Rotterdam, the Netherlands. Intervention schools adopted the 'Water Campaign', an intervention developed using Social Marketing. Control schools continued with their regular health promotion programme. Primary outcome was children's SSB consumption, measured using parent and child questionnaires and through observations at school, both at baseline and after one year of intervention.

Results: Significant positive intervention effects were found for average SSB consumption (B -0.19 litres, 95%CI -0.28;-0.10; parent report), average SSB servings (B -0.54 servings, 95%CI -0.82;-0.26; parent report) and bringing SSB to school (OR 0.51, 95%CI 0.36;0.72; observation report).

Conclusions: This study supports the effectiveness of the 'Water Campaign' intervention in reducing children's SSB consumption. Further studies are needed to replicate our findings.

Background

Weight gain and subsequent overweight in children is a growing problem worldwide. One of the contributions to this problem is thought to be the consumption of sugar-sweetened beverages (SSB) [1-6]. Indeed, small reductions in daily SSB servings have been shown to potentially improve health [7, 8]; for example De Ruyter et al. showed that over a period of 18 months, children who replaced one SSB serving per school day with a non-caloric drink gained less weight, with an average difference of 1.0 kg [7]. Several other intervention studies with water as an alternative drink have demonstrated successful behavioural changes, weight loss and other health benefits [9-13].

As the number of obese children is not declining – at best it is levelling off [14-16] – effective interventions aimed at supporting a healthy lifestyle are needed. Schools are a relevant setting in which to improve healthy lifestyles among children, not only because most children attend school, but also because it allows an intervention to reach children with varied ethnicities and socio-economic backgrounds [17-26]. Nevertheless, schools are not the only setting that needs to be addressed. Parents also play an essential role in establishing healthy habits in children [24, 27-31]. In addition, the wider environment outside schools contains many so-called obesogenic determinants that should be targeted to promote a healthy environment. This means that interventions are needed at multiple levels [32-34]. As an example, Bleich showed that community-based interventions that have a school component are more effective at preventing childhood overweight than interventions that are only school-based or only community-based [35]. Community involvement may also contribute to more sustainable programmes with higher reach and more impact [18, 32, 36-38]. It has therefore been suggested that childhood overweight must be addressed in multiple settings, i.e., at the individual, family, school and community level [17, 18, 24, 33, 35, 39, 40]. This advice with regard to multiple settings has led to initiatives such as the European EPODE network (where EPODE is a French acronym that stands for 'Together let's prevent childhood obesity') and its Dutch version JOGG (‘Jongeren op Gezond Gewicht’, meaning ‘Youth at a Healthy Weight’), which are both using an approach that incorporates Social Marketing techniques [41-43]. These techniques are expected to enhance the outcomes of integrated approaches since many other Social Marketing-based programmes throughout the world have been successful [18, 36, 44-51].

Recently, within the JOGG city network in Rotterdam an intervention was developed aimed at reducing SSB intake. This water promotion intervention, called the 'Water Campaign', is school- and community-based and applies Social Marketing. The 'Water Campaign' is an intervention tailored to children (aged 6 to 12 years old) and their families who live in multi-ethnic, disadvantaged neighbourhoods; populations who remain disproportionately affected by childhood overweight [15, 52-54].

In this study, we evaluate the effectiveness of the 'Water Campaign'. We hypothesized that after one year of intervention, children in the intervention group would have a lower SSB intake than children in the control group.

Methods

Intervention condition

The 'Water Campaign' consists of lessons at school combined with integrated community activities that promote water consumption in various ways. Table 1 provides an overview of the 'Water Campaign' activities. The intervention was developed by the local government using health promotion tools – Intervention Mapping [55] – in combination with Social Marketing. According to French et al., Social Marketing aims to change voluntary behaviour by taking the needs and wishes of the target audience as the starting point and from there trying to understand how best to promote the desired behaviour using an integrated, tailored approach [43].

Following the Social Marketing guidelines, desk research and focus-group interviews were applied to identify specific risk groups and risk behaviours. Based on these results, the local government intervention-development team decided to focus the 'Water Campaign' on Moroccan and Turkish families [52]. These families form a large group of non-Western immigrants in the study area, a group disproportionately affected by childhood overweight [15, 53, 54]. Although the intervention was tailored to, pre-tested in and developed for children and mothers from these ethnic minorities, the 'Water Campaign' was delivered to all children (and their families) attending the intervention schools and/or

living in these neighbourhoods. By encouraging the children to consume more water, the 'Water Campaign' intends to reduce children's SSB intake [5, 7, 8, 10-13, 20, 23].

Table 1: Activities in the 'Water Campaign' and regular health promotion programme

Activities	Aimed at	Water Campaign	Regular programme
Three physical education lessons per week by professional physical education teacher	Children	✔	✔
School sport clubs	Children	✔	✔
Education in choosing healthy food and sports	Children & parents	✔	✔
School dietician	Children & parents	✔	✔
Annual height and weight measurements (for BMI tracking) and fittest	Children & parents	✔	✔
Additional non-compulsory play and sports activities outside school hours	Children	✔	✔
Special event: 'Water Campaign' kick-off 'Drinking water is fun!'	Children & parents	✔	
Use of promotional material: posters '*Water is the best thing I can give to my child!*'	Children & parents	✔	
Activity *For children:* Pimp up your water bottle *For parents:* Pimp up your water jug	Children & parents	✔	
Provision of free water bottles by community organizations during summer activities	Children	✔	
Provision of free water at school throughout the day	Children	✔	
Taking a water break during physical education lessons; parents responsible for giving the child his/her water bottle to school	Children & parents	✔	
Water theme week, including activities *For children:* special educational water lessons, fun games such as happy families, board and card games involving water consumption, and a special water show provided by children's role models *For parents:* storytelling about promoting water consumption, different fun games involving water consumption and other aspects of water, including a water magazine for mothers; and promotion by water ambassadors	Children & parents	✔	

Control condition

The intervention and control schools continued with their regular health promotion programme, the effective school-based curriculum 'Enjoy Being Fit' (EBF). Initiated in 2006, this multi-component programme for primary school children encourages a healthy lifestyle by educating children and providing additional extracurricular physical activity lessons [56]. This programme addresses behavioural and environmental determinants based on elements of the 'Environmental Research framework for weight Gain prevention' [33]. A more detailed description of the EBF programme and a study describing its effects is provided elsewhere [57].

Study design

To evaluate the 'Water Campaign', we conducted a controlled trial with baseline measures collected prior to the intervention and follow-up measures after one year of intervention. A controlled design was chosen for practical reasons that were related to the spread of intervention activities throughout the community. Four schools were included, which were randomly allocated to either intervention or control condition. The Medical and Ethical Review Committee of the Erasmus Medical Centre issued a 'declaration of no objection' (i.e., formal waver) for this study (reference number MEC-2011-183). Parents and children were informed about the study and were free to refuse participation without giving any explanation.

The primary outcome measure was children's SSB consumption, which was estimated by means of parent and child questionnaires and observations of drinks brought to school. Blinding of participants and data collectors was not possible since the 'Water Campaign's' activities were visible at the intervention schools and throughout the neighbourhoods.

COURSE OF STUDY ENROLLMENT AND MEASUREMENTS

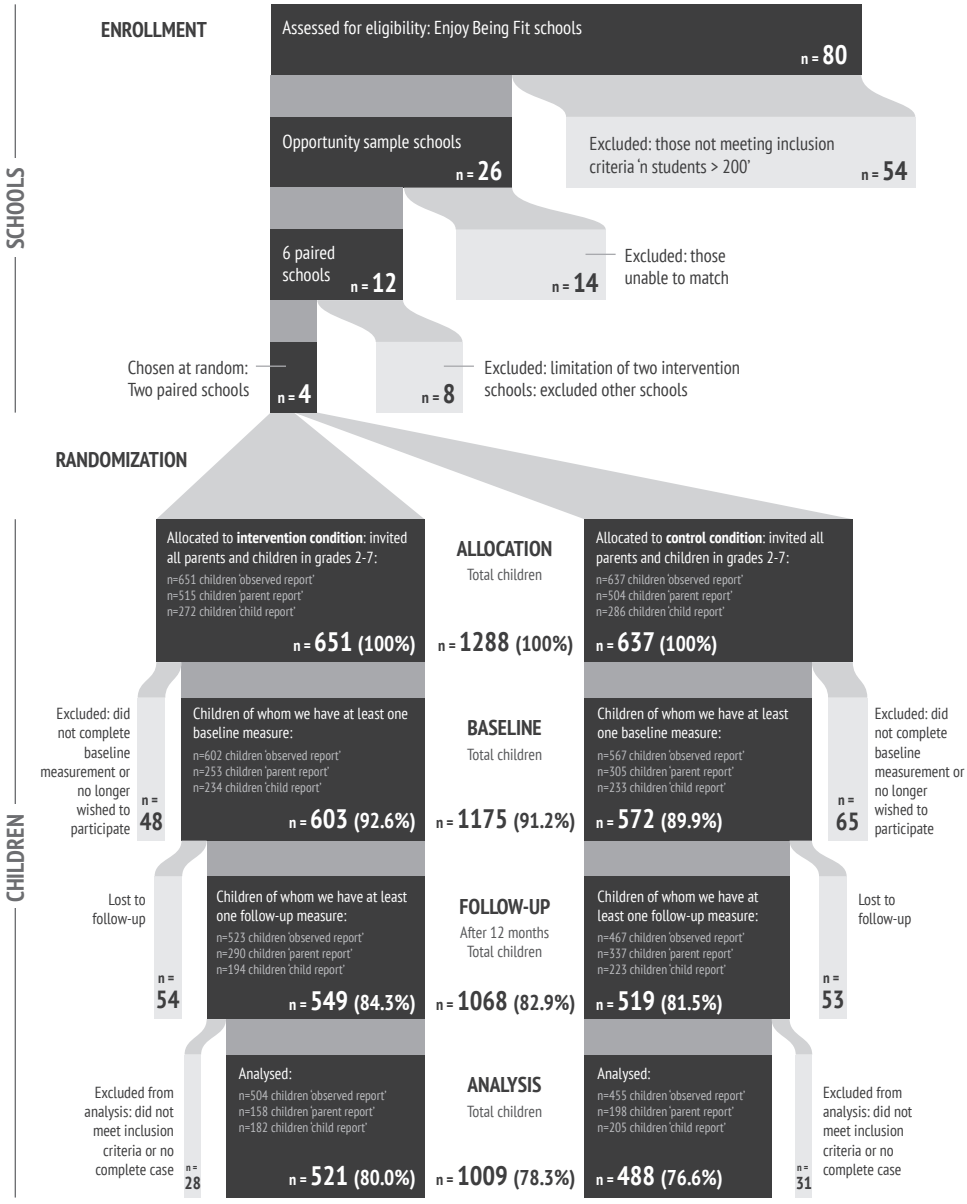


Figure 1: Overview of the course of the study

Sample and participants

Two intervention schools were assigned to the 'Water Campaign'. A total of four schools, located in four different non adjacent neighbourhoods in Rotterdam, the Netherlands, were matched in pairs of two. The matched schools had a roughly equal number of pupils, had pupils of similar socio-economic status, and had a similar prevalence of overweight. On the basis of these criteria, we were able to select only six school pairs from the 80 schools that were eligible for the study. These pairs were then approached based on convenience, in the knowledge that a school pair could only be included in the study if both schools in the pair provided consent and a maximum of two school pairs in total could be included in the study. One of the schools in the school pair was then allocated to either the intervention or control condition by the flip of a coin. Figure 1 provides an overview of study enrolment and participant flow. At the four participating schools, all children in grades 2 to 7 (aged 6 to 12 years old) were invited to participate, as were their parents.

Power

The study was powered to detect a difference in SSB servings of 0.50 per day between the intervention and control groups. We hereby assumed a standard deviation of 1.00 serving, with a power of 0.80 and an alpha of 0.05 (two-sided), taking into account adjustment of baseline values and loss to follow-up (assuming a correlation of 0.80 between baseline and follow-up measurements).

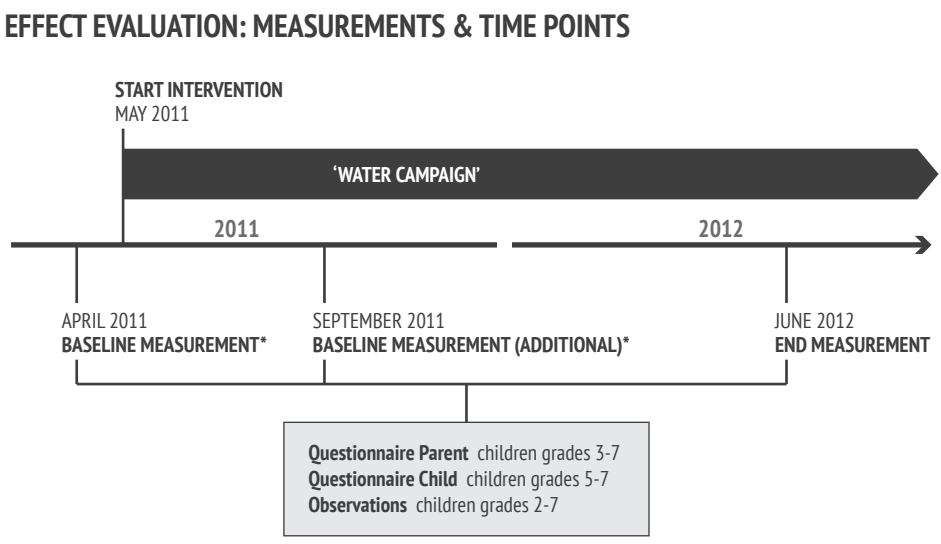
Measurements

Data on children's SSB consumption and socio-demographic characteristics were collected at baseline and after one year of intervention, using parent and child questionnaires (assessed separately) and observations at school.

The parents of all children in grades 3 to 7 (aged 6 to 12 years old) received the questionnaire at two time points: at baseline (April 2011) and after one year of intervention (June 2012). Children in grades 5 to 7 (aged 9 to 12 years old) were invited to complete child questionnaires at two time points: at baseline (April 2011-September 2011) and after one year of intervention (June 2012). The observations of children in grades 2 to 7 took

place at two time points: at baseline (April 2011-September 2011) and after one year of intervention (June 2012).

Since the intervention was implemented over two school years, it was necessary to combine the baseline measurements for the child questionnaire and the observations. Children in grades 6 and 7 completed the baseline questionnaire in April 2011; children in grade 5 (and children in grades 6 and 7 who were absent during the April measurement) completed their baseline questionnaire in September 2011. Children in grades 3 to 7 were observed for baseline measurement in April 2011 and children in grade 2 (and children grades 3 to 7 who were absent during the April measurement) were observed for baseline measurement in September 2011. Hypothetically, the fact that we used a combined baseline could have led to underestimation of effect because some children had already been exposed to the intervention. However, when we repeated the analyses using only the April 2011 data as baseline measurement we found similar results (data not shown). An overview of the data collection is presented in Figure 2.



* Combined baseline measurement of the child questionnaire and the observations were necessary due to the duration of the intervention over different school years:
- **Questionnaire child**: baseline measurement in April 2011 for children grades 6 and 7 and in September 2011 for children grade 5 (and children grades 6 and 7 who were absent during the April measurement)
- **Observations**: baseline measurement in April 2011 for children grades 3-7 and in September 2011 for children grade 2 (and children grades 3-7 who were absent during the April measurement)

Figure 2: Overview of the data collection

SSB consumption

The following definition of SSB was used: beverages containing added sugar, sweetened dairy products (e.g., chocolate milk), fruit juice (e.g., apple juice), soft drinks (e.g., cola) and energy drinks (e.g., sport energy drinks).

The consumption of SSB was assessed using similar questionnaire items for both parents and children (an overview of several items used in the parent and child questionnaire to assess child's SSB intake are shown in Supplement 1). Examples of SSB were provided, based on our definition of SSB. First, we asked whether the child consumed SSB on a daily basis. Answer categories were 'yes, every day'; 'no, not every day'; and 'never', except for the baseline parent questionnaire, where the answer categories were only 'yes, every day' or 'no, not every day'. At follow-up, this outcome measure was recoded into 'yes, every day' and 'no, not every day' (including 'never').

Average SSB intake was measured by asking the child or parent to indicate how many glasses (250ml), cans (330ml) or bottles (500ml) the child consumed on an average day on which the child drank SSB. Answer categories ranged from 'none' to '5 or more'. The total SSB intake per day, converted to litres, was calculated by summing up the multiplications of the number of glasses, cans or bottles with their volume. The average number of SSB servings was measured using the same question, adding up the number of glasses, cans or bottles that were reported to be consumed (under the assumption that a child would not consume multiple SSB drinks at once, e.g., consuming a glass and a can SSB simultaneously).

Observations at school were conducted by trained observers, who objectively recorded one morning on a random school day the drinks that the children brought to consume at school during morning break (10:00 am). Before analysis, the beverages were classified as 'SSB' or 'not SSB' based on the definition provided above.

Socio-demographic factors

The parent and child questionnaires included items on child's gender, age, grade and ethnic background. Ethnic background was determined by the country of birth of the parents according to definitions given by Statistics Netherlands [58]. The child's ethnic background was defined as Dutch only if both parents had been born in the Netherlands; if one of the parents had been born in another country, ethnic background was defined

according to that country; and if both parents had been born in different foreign countries, ethnic background was defined as the mother's country of birth. Ethnic background was categorized as either Dutch, Surinamese/Antillean, Moroccan/Turkish or other/unknown.

Gender, age and educational level of the caregiver were also recorded. The caregiver's highest educational level was categorized as either 'high' (high/mid-high); 'low' (mid-low/low); or 'unknown', based on standard Dutch cut-off points [59].

Weight status

Trained personnel measured height and weight at baseline. Weight status was determined by calculating the Body Mass Index (BMI) in kg/m^2 with height measured to the nearest 0.1cm and weight measured to the nearest 0.2kg, in light clothing or gym clothes, according to a national standardized protocol for Youth Health Care, taking into account the child's age and gender [60]. Children were categorized as being either 'non-overweight' or 'overweight/obese', based on BMI cut-off points published by the International Obesity Task Force [61].

Data analysis

To evaluate the 'Water Campaign's' effects on SSB consumption, we used the following three data sets: (1) data collected using parent questionnaires, from now on referred to as the 'parent report'; (2) data collected using child questionnaires, from now on referred to as the 'child report'; and (3) data collected using observations, from now on referred to as the 'observation report'. All statistical analyses were performed using SPSS, version 21.0.

In all data sets, outliers were checked and implausible recordings were recoded as missing. For children lost to follow-up, we performed additional analyses that compared their data with that of children for whom follow-up data was complete. T-tests and Pearson Chi-square tests were used for comparisons at baseline.

To evaluate the intervention's effectiveness, regression analyses were applied with a significance level of $p<0.05$. Multilevel analyses were not possible due to the low number of clusters (i.e., four schools)[62]. Only complete case analyses were performed, meaning

we analysed data only from children whose data from both time points was complete. The dependent variable was defined as the SSB measurement after one year of intervention. This meant that for the 'parent report' and 'child report' the outcome measures were 'daily SSB consumption (yes/no)' and 'average SSB intake (in litres and number of servings)'; and for the 'observation report' the outcome measure was 'daily SSB intake (yes/no)'. The condition (intervention/control) was entered as the independent variable. In all analyses, outcome measures were adjusted for baseline SSB values, several socio-demographic characteristics (grade, gender and ethnic background of the child and educational level of the caregiver) and child's weight status at baseline. This was done by also entering them as independent variables. For the 'parent report', the caregiver's age and gender were added to the analyses as a potential confounder if these variables differed at baseline between the intervention and control group. No imputations were performed for these potential confounders given the relatively small number of missing data points (range n=3-35). Additionally, the analyses were corrected with the variable 'school pair' to adjust for the matching of schools. We explored interaction effects of 'condition' on the socio-demographic variables, child's weight status at baseline and school pair ($p<0.10$)[63].

Results

In total, 1288 children were invited to participate in this study. At baseline, response was 54.8% among parents, 83.7% among children, and 90.8% for the observations. At follow-up, response was 61.5% among parents, 74.7% among children, and 76.9% for the observations.

We were able to conduct non-response analyses for the variables gender, grade and ethnic background of the child. Parents of children who participated in the study were more often parents of children in the lower grades ($p<0.001$) and of children with a Dutch ethnic background ($p<0.001$) as compared to parents lost to follow-up. Children who completed a questionnaire were more often children in the lower grades ($p<0.001$) and children with a Dutch ethnic background ($p=0.007$) as compared to children lost to follow-

up. Children who were observed were more often children with a non-Dutch ethnic background (p<0.001) as compared to children lost to follow-up.

Non-response analyses were also conducted for the condition variable. Here we saw a difference between the intervention and control conditions in parents of children who participated in the study compared to parents lost to follow-up (p=0.006) and for children who underwent observation compared to children lost to follow-up (p=0.014).

As shown in the flowchart depicted in Figure 1, the population for analysis comprised of 356 children using the data from the 'parent report' (34.9%); of 387 children using the data from the 'child report' (69.4%); and of 959 children using the data from the 'observation report' (74.5%). This meant that at least one complete case analysis could be performed for 1009 children (78.3%). In Supplement 2, Figure S1, a diagram is depicted to provide information on the combinations of responses between the three data reports.

Baseline characteristics

Baseline measures of child and caregiver characteristics in both conditions are shown in Table 2. Children in the intervention condition were more often children in the higher grades ('observation report' p<0.016), more often children with a non-Dutch ethnic background ('parent report' p=0.033; 'child report' p=0.001; 'observation report' p<0.001), more often children of caregiver with lower educational levels ('child report' p=0.001; 'observation report' p<0.001), and more often children of younger caregivers ('parent report' p<0.001) as compared to children in the control condition.

Table 2: Child and caregiver characteristics at baseline, in intervention and control group (n=1288)

Variable	Parent report [a] (children grades 3-7) *n* = 356			Child report [a] (children grades 5-7) *n* = 387			Observation report [a] (children grades 2-7) *n* = 959		
	Control (*n*=198, 55.6%)	Inter-vention (*n*=158, 44.4%)	*P*-value[b]	Control (*n*=205, 53.0%)	Inter-vention (*n*=182, 47.0%)	*P*-value[b]	Control (*n*=455, 47.4%)	Inter-vention (*n*=504, 52.6%)	*P*-value[b]
CHILD									
Gender			0.625			0.386			0.826
% female	57.7	55.1		55.0	50.6		52.9	52.2	
Grades			0.349			0.250			0.016
% Grade 2	-	-		-	-		17.0	20.0	
% Grade 3	21.5	20.3		-	-		17.0	18.8	
% Grade 4	21.5	22.2		-	-		17.0	20.4	
% Grade 5	20.5	16.5		27.3	34.6		15.6	13.7	
% Grade 6	20.0	17.1		34.6	29.7		16.1	13.8	
% Grade 7	16.4	24.1		38.0	35.7		17.2	13.1	
Ethnic background			**0.033**			**0.001**			<0.001
% Dutch	29.3	41.1		17.6	29.7		24.2	35.5	
%Surinamese/ Antillean	23.2	13.3		29.3	13.7		29.2	14.7	
% Moroccan/Turkish	30.8	27.2		33.2	32.4		27.3	32.9	
% Other/unknown	16.7	18.4		20.0	24.2		19.3	16.9	
Weight status			0.600			0.600			0.207
% overweight or obese	24.5	22.1		26.7	24.3		25.1	21.6	
CAREGIVER – if known									
Gender			0.109						
% female	82.5	88.7		-	-		-	-	
Age (in years), mean (SD)	36.82 (6.60)	39.86 (6.62)	**<0.001**	-	-		-	-	
Educational level			0.686			**0.001**			<0.001
% Unknown	2.5	2.5		20.0	33.0		24.4	37.1	
% Low	47.0	42.4		46.8	29.7		37.8	25.2	
% High	50.5	55.1		33.2	37.4		37.8	37.7	

a = participants with complete data available at baseline and after one year of intervention; b = differences between intervention condition and control condition, as measured at baseline, tested with independent-samples t-test (continuous variables) and Chi-square test (categorical variables); c = caregiver's educational level presented in the 'child report' and 'observational report' are based on data from the 'parent report'. Note: numbers printed **bold** indicate significant *P* values.

Intervention effects

Table 3 describes child's SSB consumption at baseline, with only the 'observation report' showing the frequency of SSB being brought to school to be significantly lower in the intervention group than in the control group (p<0.001).

Table 3 also shows the unadjusted and adjusted results of the regression analyses. Given the unadjusted and adjusted results are very similar, only the results based on the fully adjusted model are described. Based on the 'parent report', no intervention effects were found for the outcome measure daily SSB consumption. Intervention effects were found on the outcome measure average SSB intake (SSB consumed in litres and number of SSB servings). Average SSB consumption in the intervention group was significantly lower than that in the control group (B -0.19 litres per day, 95%CI -0.28;-0.10, p<0.001). The decrease in the number of SSB servings was also significantly higher in the intervention group than in the control group (B -0.54 servings per day, 95%CI -0.82;-0.26, p<0.001). On the basis of the 'child report' we found no significant intervention effects for any of the outcome measures (p>0.05 for daily SSB consumption and average SSB intake in litres or servings). On the basis of the 'observation report', we found the increase in SSB brought to consume at school to be significantly smaller in the intervention group than in the control group (OR 0.51, 95%CI 0.36;0.72, p<0.001).

When we evaluated interactions between condition and socio-demographic characteristics, child's weight status at baseline or school pair, we found no significant results on the basis of the 'parent report' or 'child report' (p>0.10). However, on the basis of the 'observation report', caregiver's educational level and school pair appeared to be significant as effect modifiers (p<0.10).

After conducting stratified analyses, we found no significant effect of the intervention for children of caregivers with a low educational level (high educational level OR 0.43, 95%CI 0.25;0.77, p=0.004; and unknown educational level OR 0.45, 95%CI 0.22;0.91, p=0.027).

The intervention effect was found only within one school pair (OR 0.37, 95%CI 0.22;0.64, p<0.001). Regarding the other school pair, children at the intervention school did not differ significantly from the children at the control school with respect to bringing SSB to school.

Table 3: SSB consumption in outcome measures of the intervention and control groups

Variable	n	Intervention		Control		Effect of intervention[c]					
						Unadjusted effects			Adjusted effects		
		Base-line	Follow-up	Base-line	Follow-up	B	OR	95%CI	B	OR	95%CI
Parent report											
% SSB every day	312	57.2 %	49.3 %	60.2 %	56.0 %		0.75	0.46 – 1.24		0.79	0.47 – 1.34
Average SSB (L), mean (SD)	322	0.76 (0.56)	0.66 (0.41)	0.85 (0.54)	0.84 (0.43)	**-0.16[a]**		**-0.24 – -0.07**	**-0.19[a]**		**-0.28 – -0.10**
Average SSB servings (#), mean (SD)	322	2.74 (1.68)	2.39 (1.28)	3.05 (1.61)	2.92 (1.34)	**-0.42[a]**		**-0.69 – -0.15**	**-0.54[a]**		**-0.82 – -0.26**
Child report											
% SSB every day	350	24.4 %	37.5 %	26.2 %	32.3 %		1.33	0.86 – 2.07		1.32	0.78 – 2.24
Average SSB (L), mean (SD)	365	1.31 (0.85)	1.16 (0.75)	1.49 (0.92)	1.15 (0.64)	0.06		-0.07 – 0.20	0.04		-0.10 – 0.19
Average SSB servings (#), mean (SD)	365	4.09 (2.33)	3.70 (2.10)	4.53 (2.54)	3.70 (1.88)	0.16		-0.23 – 0.54	0.05		-0.36 – 0.47
Observation report											
% SSB brought to school	902	68.7%[b]	68.8 %	79.6 % [b]	82.2 %		**0.51[a]**	**0.37 – 0.70**			**0.51[a]**

Note: Mean values (SD) of average SSB intake in litres, number of servings, and prevalence of children taking SSB with them to school. Figures are given for baseline and follow-up, in intervention and control groups. Also shown is the intervention effect (B (95% CI) and OR (95% CI)) between both groups for the parent reports (n=356), child reports (n=387) and observation reports (n=959). Significant effects are shown in **bold**. a = in favour of intervention group; b = difference ($p<0.05$) between intervention and control group at baseline; c = regression coefficients and odds ratios of the unadjusted models (only adjusted for baseline intake and school-pair) and fully adjusted models (in addition to baseline intake and school-pair, also adjusted for grade, gender, ethnic background and weight status of the child and educational level of the caregiver).

Discussion

This study evaluated the 'Water Campaign' programme. We found an effect on SSB on the basis of two of the three sources of information that were used to assess SSB consumption (i.e., 'parent report' and 'observation report').

Although the intervention had no effect on whether or not children consumed SSB on a daily basis, their average SSB consumption did change: after one year of intervention, on the basis of information gathered using the 'parent report', both average SSB consumption and average SSB servings were lower in children in the intervention group than in children in the control group. On the basis of information gathered using the 'child report', no significant differences in average SSB intake (in litres or servings) were found between children in the intervention and control group. An explanation for this discrepancy is lacking, but the lack of effect seen with the 'child report' can most likely be attributed to the fact that children are still too young to properly estimate their behaviour. Children's inability to conceptualize – not only SSB but also the concepts of frequency and averaging – make it debatable whether these young children provide valid responses to food questionnaires that have items covering periods greater than one day [64-66]. In addition, research has shown that parents are more prone to reporting socially desirable answers compared to children [67]. This could also partly explain the fact that SSB consumption reported by children was higher than that reported by parents. On the basis of the 'parent report', no differences in intervention effect were found between the younger children (grades 2 to 4) and the older children (grades 5 to 7) ($p>0.05$, data not shown). The parent-reported SSB consumption is probably more reliable and is supported by similar findings in the observations.

After one year of intervention, the number of children bringing SSB to school was lower in the intervention condition than in the control condition. Although the observations did not measure total daily SSB consumption, merely what children brought along to school for break-time, they were the most objective measure of SSB consumption in our study. Furthermore, what children bring along to school is most probably largely dependent on their parents' decisions.

The stratified analyses performed on the basis of the 'observation report' demonstrated that intervention effects are limited to subgroups. Differences in intervention effect were found between the two school pairs. Replication of the study with more clusters is recommended to confirm or reject our findings. Also, the effect of the intervention differed according to caregiver's educational level in a manner that contradicted our expectations. Because the intervention schools are located in disadvantaged neighbourhoods, we expected to see an intervention effect among children of caregiver's

who have lower levels of education. This contradictory finding could be due to some degree of response bias: we may have had higher responses from caregivers with a higher level of education. It could also be explained by the large group of caregivers with an 'unknown' educational level that we found in the 'observation report'.

A number of studies have been published on interventions that aimed to reduce SSB consumption by promoting water. These studies found similar but smaller intervention effects: for example, Tate et al. found a 80.7 ml decrease in SSB intake after a 6-month intervention and Sichieri et al. found a 55.0 ml SSB decrease after a one-year intervention [11, 13]. The study of Muckelbauer et al. found a significant increase in water consumption, but no effects on the consumption of juice or soft drinks were observed after adjustment for ethnic background and baseline intake [12]. Compared with these other studies the intervention effects in our study are thus encouraging.

Although the intervention was aimed at reducing the intake of children's SSB consumption by promoting the intake of water, water consumption was not an outcome measure of our study. Despite this, we did explore the average intake of water, measured in litres, as reported in the parent and child questionnaires. On the basis of the 'parent report', there was a significant overall increase in water intake over time in both the intervention and control groups (respectively $p<0.001$ and $p=0.015$). However, on the basis of the 'parent report' and the 'child report' we found the intervention to have no effect on children's water consumption ($p>0.05$; see Supplement 3, Table S1). When we also explored whether the decrease in SSB consumption could be explained by an increase in water intake, we found that children with reduced SSB consumption did not differ in their water consumption at follow-up ($p>0.05$; data not shown). These findings correspond with those of Veitch et al. [68]. However, since the mechanisms underlying the decrease in SSB consumption still remain unclear, further research is required.

The fact that we found an effect on SSB consumption does not necessarily imply a decrease in total energy intake or weight gain. However, a number of studies have indicated that a reduction in SSB consumption can have beneficial effects on total energy intake and BMI/weight status. For instance, Daniels and Popkin demonstrated that replacing SSB with water reduced total energy intake, implying less weight gain which may well contribute to preventing overweight [9]. In addition, the study by De Ruyter et al.

demonstrated that replacing SSB with sugar-free alternatives resulted in reduced weight gain [7]. We explored the effects of the intervention on child's BMI and weight status which are shown in Supplement 4, Table S2. Children in the intervention group had a significant higher increase of BMI compared to children in the control group (0.26 BMI, 95%CI 0.11;0.40, p=0.001). According the effect size criteria by Cohen, this can be regarded as a negligible effect (*d*=0.03)[69].

The intervention in our study was a school- and community-targeted intervention, developed using Social Marketing. Our results suggest that a combined school and community approach may be beneficial for children to successfully develop healthier intake of drinks, supporting Bleich's findings [35]. Furthermore, the use of Social Marketing meant that it was also possible to aim the intervention at a specific population (i.e., Moroccan and Turkish families) within a specific setting (i.e., disadvantaged neighbourhoods). However, when we explored whether such tailoring of the 'Water Campaign' specifically to these minorities improved the effects seen among these children, we were unable to detect significant differences in intervention effect between children of Moroccan and Turkish background and children from other ethnic backgrounds (p>0.05 in all three data sets; data not shown). However, the fact that the intervention had similar effects among all ethnic groups could be an indication that the reach and participation among this hard-to-reach target audience has improved, possibly due to the application of Social Marketing. We recommend that future studies should include a larger sample to increase the power for detecting behavioural changes within such a varied population.

Strengths and limitations

The main strengths of this study are the setting and the duration (i.e., activities in daily practice at primary schools and in neighbourhoods for over a year). The study's pragmatic setting means that the effects can be generalized to similar settings. A further strength of this study is that we used observations as well as questionnaires to determine the children's SSB consumption.

A limitation of this study is the fact that randomization on the individual level was not possible. A further limitation is the small number of clusters (i.e., four), which inhibited

multi-level analyses but was countered by adding the 'school pair' variable in the analyses. Since the use of self-report questionnaires to assess behavioural change is subject to limitations (e.g., misreporting of behaviour and providing socially acceptable answers), we used different methods (i.e., observations and questionnaires) and assessed questionnaires from both parents and children. The non-response of parents to the parent questionnaire (complete case analyses only possible for 35%) is another limitation of this study. Our study included a diverse group of children with different ethnic backgrounds; between the three data reports the child's ethnic backgrounds differed in distribution. Although no intervention effect of ethnic background and intervention condition was found, the intervention effects should be interpreted and generalized with caution (especially our findings based on the 'parent report'). We assessed SSB intake 'on average a day' with the parent and child questionnaires and observed SSB consumption 'on a random school day'. Further research is recommended to gain insight into different patterns of the child's SSB consumption (e.g., on week-days vs. weekend-days). It may be debatable whether some beverages should be in- or excluded from the definition 'SSB'. We recognize that some beverages may have additional nutritional benefits for children; however, we defined SSB in this study based on the amount of sugar within the beverages. A next step in altering the child's consumption intake could be to give attention to and differentiate even more between SSB's with and without nutritional value for the child's diet. Finally, the 'Water Campaign' consists of several components that promote water consumption. However, when applying such a multi-component intervention, it remains unclear which intervention activities are essential for obtaining the observed effects. We were unable to gather detailed implementation information as it was impossible to register the delivery of components at an individual level. Further research is therefore needed to understand the pathways of the behaviour changes that seem to have occurred.

Conclusions

The findings of this study support the effectiveness of the 'Water Campaign' in reducing the consumption of SSB, adding to evidence from other studies. Further studies are

required to replicate the findings and to elucidate the possible mechanism underlying this intervention effect, the impact on BMI and the effectiveness in different subgroups. We also suggest that the 'Water Campaign' be evaluated in other settings, using larger samples and with longer follow-up. In the meantime, we recommend that schools and communities be aware of water as thirst-quencher, and as an alternative for SSB.

References

1. Ludwig DS, Peterson KE, Gortmaker SL. Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet* 2001; **357**(9255)**:** 505-8.
2. Mrdjenovic G, Levitsky DA. Nutritional and energetic consequences of sweetened drink consumption in 6- to 13-year-old children. *J Pediatr* 2003; **142**(6)**:** 604-10.
3. Vartanian LR, Schwartz MB, Brownell KD. Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. *Am J Public Health* 2007; **97**(4)**:** 667-75.
4. Malik VS, Willett WC, Hu FB. Sugar-sweetened beverages and BMI in children and adolescents: reanalyses of a meta-analysis. *Am J Clin Nutr* 2009; **89**(1)**:** 438-9; author reply 439-40.
5. Deboer MD, Scharf RJ, Demmer RT. Sugar-Sweetened Beverages and Weight Gain in 2- to 5-Year-Old Children. *Pediatrics* 2013.
6. Hu FB. Resolved: there is sufficient scientific evidence that decreasing sugar-sweetened beverage consumption will reduce the prevalence of obesity and obesity-related diseases. *Obes Rev* 2013; **14**(8)**:** 606-19.
7. de Ruyter JC, Olthof MR, Seidell JC, Katan MB. A trial of sugar-free or sugar-sweetened beverages and body weight in children. *N Engl J Med* 2012; **367**(15)**:** 1397-406.
8. Ebbeling CB, Feldman HA, Chomitz VR, Antonelli TA, Gortmaker SL, Osganian SK *et al.* A randomized trial of sugar-sweetened beverages and adolescent body weight. *N Engl J Med* 2012; **367**(15)**:** 1407-16.
9. Daniels MC, Popkin BM. Impact of water intake on energy intake and weight status: a systematic review. *Nutr Rev* 2010; **68**(9)**:** 505-21.
10. Pan A, Malik VS, Schulze MB, Manson JE, Willett WC, Hu FB. Plain-water intake and risk of type 2 diabetes in young and middle-aged women. *Am J Clin Nutr* 2012; **95**(6)**:** 1454-60.
11. Tate DF, Turner-McGrievy G, Lyons E, Stevens J, Erickson K, Polzien K *et al.* Replacing caloric beverages with water or diet beverages for weight loss in adults: main results of the Choose Healthy Options Consciously Everyday (CHOICE) randomized clinical trial. *Am J Clin Nutr* 2012; **95**(3)**:** 555-63.
12. Muckelbauer R, Libuda L, Clausen K, Toschke AM, Reinehr T, Kersting M. Promotion and provision of drinking water in schools for overweight prevention: randomized, controlled cluster trial. *Pediatrics* 2009; **123**(4)**:** e661-7.
13. Sichieri R, Paula Trotte A, de Souza RA, Veiga GV. School randomised trial on prevention of excessive weight gain by discouraging students from drinking sodas. *Public Health Nutr* 2009; **12**(2)**:** 197-202.
14. Olds T, Maher C, Zumin S, Peneau S, Lioret S, Castetbon K *et al.* Evidence that the prevalence of childhood overweight is plateauing: data from nine countries. *Int J Pediatr Obes* 2011; **6**(5-6)**:** 342-60.

15. Schonbeck Y, Talma H, van Dommelen P, Bakker B, Buitendijk SE, Hirasing RA *et al.* Increase in prevalence of overweight in Dutch children and adolescents: a comparison of nationwide growth studies in 1980, 1997 and 2009. *PLoS ONE* 2011; **6**(11)**:** e27608.

16. Wabitsch M, Moss A, Kromeyer-Hauschild K. Unexpected plateauing of childhood obesity rates in developed countries. *BMC Med* 2014; **12**(1)**:** 17.

17. Roseman MG, Riddell MC, Haynes JN. A content analysis of kindergarten-12th grade school-based nutrition interventions: taking advantage of past learning. *J Nutr Educ Behav* 2011; **43**(1)**:** 2-18.

18. Romon M, Lommez A, Tafflet M, Basdevant A, Oppert JM, Bresson JL *et al.* Downward trends in the prevalence of childhood overweight in the setting of 12-year school- and community-based programmes. *Public Health Nutr* 2009; **12**(10)**:** 1735-42.

19. Gonzalez-Suarez C, Worley A, Grimmer-Somers K, Dones V. School-based interventions on childhood obesity: a meta-analysis. *Am J Prev Med* 2009; **37**(5)**:** 418-27.

20. Singh AS, Chin APMJ, Brug J, van Mechelen W. Dutch obesity intervention in teenagers: effectiveness of a school-based program on body composition and behavior. *Arch Pediatr Adolesc Med* 2009; **163**(4)**:** 309-17.

21. Katz DL, O'Connell M, Njike VY, Yeh MC, Nawaz H. Strategies for the prevention and control of obesity in the school setting: systematic review and meta-analysis. *Int J Obes (Lond)* 2008; **32**(12)**:** 1780-9.

22. Kropski JA, Keckley PH, Jensen GL. School-based obesity prevention programs: an evidence-based review. *Obesity (Silver Spring)* 2008; **16**(5)**:** 1009-18.

23. James J, Thomas P, Kerr D. Preventing childhood obesity: two year follow-up results from the Christchurch obesity prevention programme in schools (CHOPPS). *BMJ* 2007; **335**(7623)**:** 762.

24. Warren JM, Henry CJ, Lightowler HJ, Bradshaw SM, Perwaiz S. Evaluation of a pilot school programme aimed at the prevention of obesity in children. *Health Promot Int* 2003; **18**(4)**:** 287-96.

25. Johnston CA, Moreno JP, El-Mubasher A, Gallagher M, Tyler C, Woehler D. Impact of a school-based pediatric obesity prevention program facilitated by health professionals. *J Sch Health* 2013; **83**(3)**:** 171-81.

26. Story M, Kaphingst KM, French S. The role of schools in obesity prevention. *Future Child* 2006; **16**(1)**:** 109-42.

27. Sleddens EF, Gerards SM, Thijs C, de Vries NK, Kremers SP. General parenting, childhood overweight and obesity-inducing behaviors: a review. *Int J Pediatr Obes* 2011; **6**(2-2)**:** e12-27.

28. West F, Sanders MR, Cleghorn GJ, Davies PS. Randomised clinical trial of a family-based lifestyle intervention for childhood obesity involving parents as the exclusive agents of change. *Behav Res Ther* 2010; **48**(12)**:** 1170-9.

29. Golley RK, Hendrie GA, Slater A, Corsini N. Interventions that involve parents to improve children's weight-related nutrition intake and activity patterns - what nutrition and activity targets and behaviour change techniques are associated with intervention effectiveness? *Obes Rev* 2011; **12**(2)**:** 114-30.

30. Hebden L, Hector D, Hardy LL, King L. A fizzy environment: availability and consumption of sugar-sweetened beverages among school students. *Prev Med* 2013; **56**(6)**:** 416-8.

31. 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**(2)**:** 129-54.

32. 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* 1999; **29**(6 Pt 1)**:** 563-70.

33. Kremers SP, de Bruijn GJ, Visscher TL, 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.

34. Brug J, van Lenthe FJ, Kremers SP. Revisiting Kurt Lewin: how to gain insight into environmental correlates of obesogenic behaviors. *Am J Prev Med* 2006; **31**(6)**:** 525-9.

35. Bleich SN, Segal J, Wu Y, Wilson R, Wang Y. Systematic review of community-based childhood obesity prevention studies. *Pediatrics* 2013; **132**(1)**:** e201-10.

36. Mathews LB, Moodie MM, Simmons AM, Swinburn BA. The process evaluation of It's Your Move!, an Australian adolescent community-based obesity prevention project. *BMC Public Health* 2010; **10:** 448.

37. Barlow SE, Expert C. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics* 2007; **120 Suppl 4:** S164-92.

38. *Centre for Public Health Excellence at NICE; National Collaborating Centre for Primary Care: Obesity: The Prevention, Identification, Assessment and Management of Overweight and Obesity in Adults and Children.* National Institute for Health and Clinical Excellence: London, 2006.

39. Robertson W, Friede T, Blissett J, Rudolf MC, Wallis M, Stewart-Brown S. Pilot of "Families for Health": community-based family intervention for obesity. *Arch Dis Child* 2008; **93**(11)**:** 921-6.

40. Birch LL, Ventura AK. Preventing childhood obesity: what works? *Int J Obes (Lond)* 2009; **33 Suppl 1:** S74-81.

41. Network EE. EPODE European Network In.

42. Gewicht) YoHWJOG. "Youth on Healthy Weight" (Jongeren Op Gezond Gewicht). In.

43. French J B-SC, McVey D, and Merritt R. *Social Marketing and Public Health – Theory and Practice*, Oxford University Press: Oxford, 2010.

44. Evans WD, Christoffel KK, Necheles JW, Becker AB. Social marketing as a childhood obesity prevention strategy. *Obesity (Silver Spring)* 2010; **18 Suppl 1:** S23-6.

45. Evans WD. How social marketing works in health care. *BMJ* 2006; **332**(7551)**:** 1207-10.

46. Gracia-Marco L, Vicente-Rodriguez G, Borys JM, Le Bodo Y, Pettigrew S, Moreno LA. Contribution of social marketing strategies to community-based obesity prevention programmes in children. *Int J Obes (Lond)* 2011; **35**(4)**:** 472-9.

47. Rayner M. Social marketing: how might this contribute to tackling obesity? *Obes Rev* 2007; **8 Suppl 1:** 195-9.

48. Evans WD, Necheles J, Longjohn M, Christoffel KK. The 5-4-3-2-1 go! Intervention: social marketing strategies for nutrition. *J Nutr Educ Behav* 2007; **39**(2 Suppl)**:** S55-9.

49. Huhman ME, Potter LD, Nolin MJ, Piesse A, Judkins DR, Banspach SW *et al.* The Influence of the VERB campaign on children's physical activity in 2002 to 2006. *Am J Public Health* 2010; **100**(4)**:** 638-45.

50. Wong FL, Greenwell M, Gates S, Berkowitz JM. It's what you do! Reflections on the VERB campaign. *Am J Prev Med* 2008; **34**(6 Suppl)**:** S175-82.

51. Government UK. Change 4 Life - One Year On. In: U.K. Government, 2010.

52. *"City of Rotterdam: Scoping Enojy Being Fit Family Approach" (Scoping Rapport: Gezinsaanpak Lekker Fit!)*. Department of Sports and Culture, City of Rotterdam: Rotterdam, the Netherlands, 2012.

53. Fredriks AM, Van Buuren S, Sing RA, Wit JM, Verloove-Vanhorick SP. Alarming prevalences of overweight and obesity for children of Turkish, Moroccan and Dutch origin in The Netherlands according to international standards. *Acta Paediatr* 2005; **94**(4)**:** 496-8.

54. Youth Rijnmond 2011 [GGD Rotterdam: Jeugd Rijnmond in Beeld 2011, Gemeenterapport Rotterdam]. In. Rotterdam, the Netherlands: Department of Youth and Education, Municipal Health Service Rotterdam-Rijnmond, 2012.

55. Bartholomew LK, Parcel GS, Kok G. Intervention mapping: a process for developing theory- and evidence-based health education programs. *Health Educ Behav* 1998; **25**(5)**:** 545-63.

56. Jansen W, Raat H, Zwanenburg EJ, Reuvers I, van Walsem R, Brug J. A school-based intervention to reduce overweight and inactivity in children aged 6-12 years: study design of a randomized controlled trial. *BMC Public Health* 2008; **8:** 257.

57. Jansen W, Borsboom G, Meima A, Zwanenburg EJ, Mackenbach JP, Raat H *et al.* Effectiveness of a primary school-based intervention to reduce overweight. *Int J Pediatr Obes* 2011; **6**(2-2)**:** e70-7.

58. Swertz O, Duimelaar P, Thijssen J. *Statistics Netherlands. Migrants in the Netherlands 2004.* Statistics Netherlands: Voorburg/Heerlen, the Netherlands, 2004.

59. *Dutch Standard Classification of Education 2003*. Statistics Netherlands: Voorburg/Heerlen, Netherlands, 2004.

60. Bulk-Bunschoten AMW, Renders CM, Leerdam FJM, Hirasing RA. *Protocol for detection of overweight in preventive youth health care. [Signaleringsprotocol overgewicht in de jeugdgezondheidszorg]*. VUMC: Amsterdam, 2004.

61. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000; **320**(7244)**:** 1240-3.

62. Campbell MK, Piaggio G, Elbourne DR, Altman DG, Group C. Consort 2010 statement: extension to cluster randomised trials. *BMJ* 2012; **345:** e5661.

63. Sun X, Briel M, Walter SD, Guyatt GH. Is a subgroup effect believable? Updating criteria to evaluate the credibility of subgroup analyses. *BMJ* 2010; **340:** c117.

64. Smith AF, Baxter SD, Hardin JW, Guinn CH, Royer JA. Relation of Children's Dietary reporting accuracy to cognitive ability. *Am J Epidemiol* 2011; **173**(1)**:** 103-9.

65. McPherson RS, Hoelscher DM, Alexander M, Scanlon KS, Serdula MK. Dietary assessment methods among school-aged children: Validity and reliability. *Prev Med* 2000; **31**(2)**:** S11-S33.

66. Livingstone MB, Robson PJ. Measurement of dietary intake in children. *Proc Nutr Soc* 2000; **59**(2)**:** 279-93.

67. Bornhorst C, Huybrechts I, Ahrens W, Eiben G, Michels N, Pala V *et al.* Prevalence and determinants of misreporting among European children in proxy-reported 24 h dietary recalls. *Br J Nutr* 2013; **109**(7)**:** 1257-65.

68. Veitch J, Singh A, van Stralen MM, van Mechelen W, Brug J, Chinapaw MJ. Reduction in sugar-sweetened beverages is not associated with more water or diet drinks. *Public Health Nutr* 2011; **14**(8)**:** 1388-93.

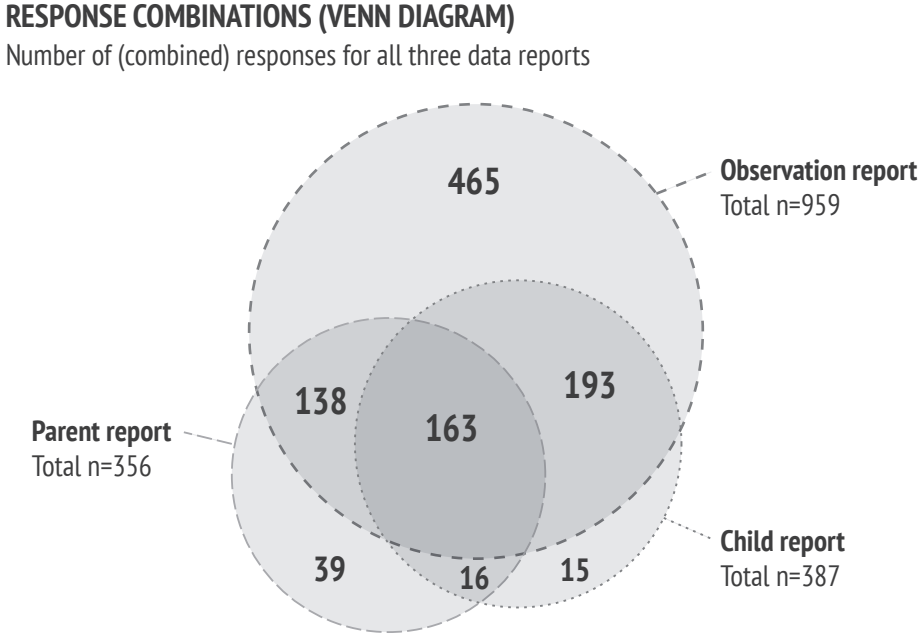
69. J. C. *Statistical power analysis for the behavioural sciences*, Academic Press: New York, 1977.

Supplements

Supplement 1. Overview of items used to assess child's SSB intake in the parent and child questionnaire

Questionnaire items to assess child's SSB intake	Response categories
Introduction to questions related child's SSB intake	
Please indicate which of the drinks below your child (you) consume most of the times; this can be at school, at home or with friends.	☐ Coke/Pepsi ☐ Fanta/Sisi ☐ Fernandez ☐ Dr. Pepper ☐ Ice-tea ☐ Energy drinks (Redbull etc) ☐ Lemonade ☐ Apple juice ☐ Yoghurt-drinks ☐ Chocolate milk ☐ Tea with sugar
All questions below are related to so-called sugar-sweetened beverages (SSB). These are beverages containing added sugar, sweetened dairy products (e.g., chocolate milk), fruit juice (e.g., apple juice), soft drinks (e.g., cola) and energy drinks (e.g., sport energy drinks). *All of the above examples of drinks are SSB.* *Please fill in the questions below on how much SSB your child/you consume and keep above described definition and examples in mind.* *(So, do not take into account: light or sugar free beverages, water, 100% orange juice, tea without sugar, and regular milk.)*	
Does your child (do you) consume SSB on a daily basis?	☐ No, never ☐ No, not every day ☐ Yes, every day
Please indicate how many glasses (250ml – column A), cans (330ml – column B) or bottles (500ml – column C) the child (you) consumed on an average day on which the child drank SSB?	**A. Glasses**  ☐ None ☐ 1 glass ☐ 2 glasses ☐ 3 glasses ☐ 4 glasses ☐ 5 glasses **B. Cans**  ☐ None ☐ 1 can ☐ 2 cans ☐ 3 cans ☐ 4 cans ☐ 5 cans **C. Bottles**  ☐ None ☐ 1 bottle ☐ 2 bottles ☐ 3 bottles ☐ 4 bottles ☐ 5 bottles

Supplement 2. Figure S1: Response combinations for the different data reports



Supplement 3. Table S1: Changes in water consumption in the intervention and control groups*

		Intervention		Control		Effect of intervention[c]					
						Unadjusted effects			Adjusted effects		
Variable	n	Baseline	Follow-up	Baseline	Follow-up	B	OR	95%CI	B	OR	95%CI
Parent report											
Average water (L), mean (SD)	350	0.59 (0.31)	0.69 (0.33)	0.62 (0.33)	0.69 (0.33)	0.02		-0.04 – 0.08	0.03		-0.03 – 0.09
Child report											
Average water (L), mean (SD)	405	0.66 (0.29)	0.67 (0.28)	0.68 (0.28)	0.66 (0.29)	0.01		-0.04 – 0.06	0.01		-0.04 – 0.07

Note: Mean values (SD) of average water intake in litres at baseline and follow-up, in intervention and control groups. Also shown is the intervention effect (B (95% CI) and OR (95% CI)) between both groups for the parent reports (n=350) and child reports (n=405). Significant effects are shown in **bold**. a = in favour of intervention group; b = difference ($p<0.05$) between intervention and control group at baseline; c = regression coefficients and odds ratios of the unadjusted models (only adjusted for baseline intake and school-pair) and fully adjusted models (in addition to baseline intake and school-pair, also adjusted for grade, gender, ethnic background and weight status of the child and educational level of the caregiver).

Supplement 4. Table S2: Changes in BMI and weight status of the intervention and control groups*

		Intervention		Control		Effect of intervention[c]			Intervention		
						Unadjusted effects			Adjusted effects		
Variable	n	Baseline	Follow-up	Baseline	Follow-up	B	OR	95%CI	B	OR	95%CI
BMI, mean (SD)	968	17.31 (3.02)	18.10 (3.38)	17.62 (3.06)	18.24 (3.40)	**0.19**		**0.04 – 0.33**	**0.26**		**0.11 – 0.40**
Weight status, % overweight or obese	968	22.1 %	27.1 %	24.4 %	27.3 %		1.27	0.80 – 2.02		1.27	0.78 – 2.08

***** = Mean values (SD) of child's Body Mass Index (BMI) and weight status at baseline and follow-up, in intervention and control groups. Also shown is the intervention effect (B (95% CI) and OR (95% CI)) between both groups for the children under study (n=968) with significant effects shown in **bold**. a = in favour of intervention group; b = difference ($p<0.05$) between intervention and control group at baseline; c = regression coefficients and odds ratios of the unadjusted models (only adjusted for baseline intake and school-pair) and fully adjusted models (in addition to baseline intake and school-pair, also adjusted for grade, gender, ethnic background and weight status of the child and educational level of the caregiver).

9

General discussion

This thesis aims to contribute to the development, implementation and evaluation of interventions aimed to promote healthy behaviours among children living in disadvantaged neighbourhoods. Specifically, the development and effectiveness of the 'Water Campaign', a Social Marketing intervention is described. The research questions were:

For part I: Assessing nutritional behaviour of children

1) How good is the level of agreement between children's report of their own nutritional behaviour compared to reports of their parents and observed data? (chapter 2)

For part II: Determinants of health behaviours among children

2) Which family and home-related factors are associated with health behaviours among children? (chapters 3 & 4)
3) Which parenting styles and parenting feeding styles are associated with health behaviours among children? (chapter 5)

For part III: Development and effect of interventions promoting healthy behaviours among children

4) Which interventions on improving healthy behaviours of disadvantaged children in Europe are effective? (chapter 6)
5) How can Social Marketing be used in intervention development aimed to promote healthy behaviours among children? (chapter 7)
6) How effective is the 'Water Campaign' in reducing the child's intake of sugar-sweetened beverages (SSB) after one year? (chapter 8)

In this general discussion, the results of the studies presented in the thesis are summarized and interpreted alongside the existing literature. Methodological considerations with regard to the presented studies are discussed. Recommendations for future research and implications for policy and practice are given. Finally, an overall conclusion is provided.

Main findings and interpretation

In the first part of the thesis, different ways to assess nutritional behaviour of children were described. In **chapter 2**, we looked at differences in reporting by children and

parents regarding the child's water, fruit and SSB intake and also at the agreement between observations and child's report of break-time foods. Starting with the latter, we found a poor to fair level of agreement between the observed break-time foods and the children's self-report, which is similar to other studies [1, 2].We found children to report higher quantities of sandwiches and snacks than we observed. The lack of agreement may be explained by the fact that children find it difficult to estimate the amount of foods and food items [3-5]. Another possible explanation for the higher reports by children in comparison with the observed quantities of snacks as break-time food item could be due to personal preferences or personal characteristics of the child. Since snacks are more likely to be children's favourite food types, this could have been reflected in their reporting behaviour.

Looking at the agreement between the reports from parents and those from children, we found the best level of agreement for the consumption of water (daily and average amounts). The reports on daily and average amounts of SSB consumed differed substantially between children and parents. These discrepancies could be due to children being less aware of when and how much SSB they consume [3-5]. One could also consider the argument that unhealthy food or drink types such as SSB are more likely to be under-reported ('intentional selective misreporting by parents') [6-8]. This may explain why, in the current study, average amounts of SSB consumed was dissimilar between parent and child reports while average amounts of fruit and water consumed was not. Possible other explanations could be because of the problems children may still have had with what defined SSB, or because parents and children may have different perceptions about the child's food and drink intake [3]. It could also be that children bought or swapped food items without their parents knowing. Previous research among parents and children reporting on the child's consumption behaviour in comparison to observed reports showed that parental reports are slightly more accurate than children's reports when reporting on various food items and food types: 78% agreement between observed and parent reports compared with 72% agreement between observed and child reports [9]. As previously suggested, we recommend combined measurement methods when assessing child's habitual dietary behaviour on the level of pre-specified foods or food groups [10, 11]. As seen in other public health fields, the question then remains on how to process and interpret data from multiple sources [12].

The second part of this thesis described the determinants of health behaviours among children (chapters 3, 4 & 5). Insights into these determinants among young and ethnic diverse populations may help contribute to intervention development and thereby to improved reach and intervention effectiveness. In the chapters 3 and 4, we examined the influence of socio-demographic characteristics, and family and home-related determinants (cognitive, environmental and habitual factors) on children's SSB and snack consumption. These associations were also explored within ethnic subgroups. In **chapter 3**, we observed that child's age, parental attitude, parents' subjective norm, the availability of SSB at home and school, parenting practices and parental modelling to be associated with child's average SSB intake in litre per day. Our results are in line with other studies conducted among children of similar age. For instance that children of parents who have a more positive attitude towards decreasing the child's SSB intake or that children of parents with a more positive subjective norm towards their child's SSB intake, consumed less SSB [13-16]. Also in line with other studies are our findings regarding parenting practices and parental modelling; children of parents who express healthier parenting practices towards the child's SSB intake (i.e., more restrictive towards the child's SSB consumption) and children of parents who less often model SSB consumption, consumed less SSB [17-21]. The significant positive associations between parenting practices and parental modelling and the child's SSB consumption, emphasize the important role of parents in shaping the child's dietary habits [18, 20, 22-26]. Parents serve both as role model and as facilitator impacting children's consumption diet. Interventions' effectiveness may be improved if parents are involved or specifically targeted as intervention participants [20, 27-29].

Our results also provide support for differences in the associations between family and home-related factors and the child's SSB intake according to the ethnic background of the child. As emphasized in other literature, ethnic background differences may have an impact on parental beliefs regarding the child's food consumption or on rules restricting the intake of certain foods by the child [19, 30]. Our results provide support for this statement. For instance, when exploring our model for the different ethnic subgroups, we could explain almost half (44%) of the child's SSB intake for children with a Dutch ethnic background, with the factor of habit strength to be only of relevance for this group and not for any of the other ethnic subgroups. Contrary, we could explain just 9% of the child's

SSB intake for children with a Moroccan or Turkish ethnic background. Looking more specifically at factors relevant for this specific group, our findings suggest that for children with a Moroccan or Turkish ethnic background intervening on the family level may be beneficial in order to reduce SSB consumption. Intervention developers could for example address parents' modelling behaviour by including skills training and role play in interventions aimed at the family level [31].

In **chapter 4**, when examining associations of family and home-related factors and children's snack intake, we observed parents' subjective norm, parenting practices, and parental modelling to be associated with child's snack intake. Our results confirmed some results of previous studies, for instance that children of parents who express more 'favourable' parenting practices towards the child's snack intake (i.e., more restrictive towards the child's snack consumption) and children of parents who model snack consumption less often, are reported to have a lower snack intake [17, 20, 22, 32, 33]. However, contrary to other studies, we did not found any association between the reported availability of snacks in the home and the child's snack intake [33-35]. This could be due to the cross-sectional design of our study or perhaps because the children in our sample live in inner-city neighbourhoods, where ample food shops and supermarkets are present; therefore the availability at home might be relatively less important.

Comparable to our previous findings regarding determinants of child's SSB intake, analyses in subgroups according to ethnic origin yielded different associated family and home-related factors for child's snacking behaviour per ethnic subgroup. These results may have practical implications for developers of interventions. When the intervention population is diverse – e.g., ethnically or culturally diverse – there may be different factors relevant to be addressed in subgroups within the population. Health promotion professionals should be aware of different subgroups within a population and gain knowledge about these subgroups in order to be able to better tailor their intervention; a certain degree of tailoring of interventions to population subgroups may be beneficial for intervention effectiveness [30, 36, 37]. By incorporating relevant generic aspects in the intervention, all (ethnic) subgroups would benefit. An alternative approach can be to tailor interventions separate for specific subgroups [38-40]. Tailoring to all subgroups or alternatively a selection of subgroups is also possible [41]. Specific tailoring to one subgroup and broad implementation (and participation) can be combined [42]. Though an

intervention is available for everyone, one might expect to see more effective and sustainable behaviour change in the tailored subgroup compared to the other subgroups within the population [30, 43, 44]. For example, in the 'Water Campaign' intervention, different subgroups were defined within the potential intervention population [36, 45]. The 'Water Campaign' was available for everyone, but developed by tailoring to the wishes and needs of the subgroup for which the developers thought most health behaviour benefits were needed and/or could be achieved [45]. Differences in health behaviours between ethnic subgroups remains to be further explored and studied.

Also, regarding both chapters 3 and 4, the associations between demographic factors and health-related behaviours as were found in these studies, might be due to differences in health literacy [46]. How well people understand and can act on health-related information has shown to be associated with performing healthy behaviours [47]. Caregiver's health literacy has been associated with their own and their children's health outcomes [48-52]. Increased understanding of these factors and underlying mechanisms that possibly can explain the children's healthy behaviours between subgroups – either ethnically or culturally diverse – could assist to further tailor and improve interventions, in order to enhance interventions' effectiveness. This remains to be further studied.

In **chapter 5**, the influence of parenting styles and feeding styles on snacking behaviour in children were described. In line with previous studies, we observed that 'control over eating' was associated with lower unhealthy snack consumption of the child [53-55]. Though other studies suggest that an authoritative parenting style is associated with lower unhealthy snack consumption of children, we found no such association. This lack of association between parenting style and children's unhealthy snack consumption might be due to the low variability on the scores of the dimensions 'involvement' and 'strictness' among parents. Our results also suggest that the associations of feeding styles and parenting styles with children's unhealthy snack consumption differed according to the ethnic background of the child. Differences between ethnic subgroups regarding factors such as parental beliefs, knowledge or parenting practices (e.g., modelling, food availability) may have contributed to the differences in associations that we have found. To improve interventions' reach and effectiveness, developers may take into account the potential role of the child's ethnic background.

In the third part of this thesis, research questions on the development and effectiveness of interventions aimed at promoting healthy behaviours among children living in disadvantaged neighbourhoods were addressed (chapters 6, 7 & 8). In **chapter 6**, a systematic review was presented, which synthesized the evidence on the effectiveness of interventions aimed to improve healthy behaviours and/or prevent overweight among 0 to 12 year old socially disadvantaged children in Europe. The search included 13 studies. Results showed that few studies have investigated the effects of such interventions among socially disadvantaged children and even fewer studies have shown substantial and sustained effects. In general, interventions targeting multiple healthy behaviours were moderately effective in positively influencing the child's Body Mass Index (BMI), while interventions targeting one specific behaviour were moderately effective in changing (only) that behaviour. These findings are plausible given the complexity of childhood overweight involving risk factors from all domains ranging from the most proximal healthy behaviours to wider environmental and societal determinants [56-59]. With the exception of one community-based intervention, all interventions were conducted in the (pre)school setting. This made it impossible to draw conclusions regarding differential effects according to the intervention setting. There are several major advantages for the school setting, especially with respect to interventions targeting socially disadvantaged children. Amongst others, the easily implemented changes in the school without the need for parental involvement or motivation, the mandatory character of interventions, and a large reach across all social groups [60, 61]. However, the prevention of childhood overweight also requires interventions outside the school setting. Recent studies suggest that the effectiveness of school-based interventions can be substantially improved by incorporating family and community components [62, 63]. Our review found that intervention effects differ depending on the child's gender and age. More research into potential gender and age differences for the effectiveness of interventions among socially disadvantaged children is warranted. Also, other research suggests that cultural adaptation has the potential to enhance intervention relevance, effectiveness, and feasibility of interventions especially for ethnic minority groups [30]. However, in more recent research some authors emphasize that interventions in low socio-economic groups will be most effective when structural barriers constraining healthy choices are removed [64]. Given the small number of identified studies investigating the effectiveness of interventions aimed to improve healthy behaviours and/or BMI among socially

disadvantaged children in Europe, we would emphasize the necessity for more interventions aimed at this vulnerable target group. Recent studies have indicated that even on very young ages (i.e., <6 years old) children already show unhealthy behaviours [65, 66], stressing the need to intervene at a young age. To summarize, when developing interventions aimed to prevent childhood overweight, we recommend to address multiple health behaviours and multiple settings. Intervention effectiveness may be further improved by addressing structural barriers and taking into account possible cultural adaptations, specifically when tailoring the intervention for the population of socially disadvantaged children.

In the chapters 7 and 8 we described the development of the 'Water Campaign' and the intervention's effect on reducing the consumption of SSB among children. In **chapter 7**, we described how the 'Water Campaign' was developed using Social Marketing in combination with Intervention Mapping. As a Social Marketing method [42], we chose to develop the intervention using the total process planning (TPP) framework because it offers detailed guidance and techniques leading to client orientation. During the development of this campaign, the various stages of the TPP framework were processed. The findings from the extensive iterative scoping stage led us to the selection of one specific target segment. In our campaign, the focus on one fairly homogenous target segment with similar needs, beliefs, attitudes and behaviours made for a better match between the intervention components and the target segment's specific perceived needs. Previous research suggests that such a focus makes it easier for people in the target segment to adopt and sustain behaviour change [67]. The scoping stage also provided us with a deeper understanding of the problem at hand as well as of the lives of the target segment in general and what they value. These in-depth insights guided us in the selection of one specific behavioural goal, making it easier to conceive, develop and implement a realistic and achievable intervention for the specific target segment. It also meant that there was a precise way of measuring progress and intervention's impact on behaviour. This is in line with for instance the approach based on the project EPODE ('Ensemble Prévenons l'Obésité Des Enfants', meaning 'Together Let's Prevent Childhood Obesity'), where the focus is always limited to one specific theme at a time [43]. The choice to focus on one specific behavioural goal at a time is inherent to the choice to use Social Marketing. The team's choice for the target segment 'Moroccan and Turkish mothers and their

children' as well as the choice for the target behaviour 'reducing children's SSB consumption', was supported by studies in the literature [22, 68-72], local epidemiological data [73] and our information gathered from the focus groups and interviews with the target segment and local stakeholders. In order to make the behavioural change that was aimed for more explicit, we defined the desired behaviour (the behavioural exchange) as 'drinking at least two servings of water per day'. The literature supports both the choice for the promotion of water [74-77], as well as the choice for a positive message (i.e., promoting water intake) instead of a negative message (i.e., limiting SSB consumption) [78]. One could argue that the specification of 'two servings per day' is somewhat arbitrary. However, this message was chosen because pre-testing within the target segment (mothers) indicated that the advice of consuming at least two servings of water per day seemed to be a realistic, acceptable and achievable target behaviour. In the development stage the Intervention Mapping tools were embedded in the TPP framework, which enabled us to select those behavioural determinants in our target segment that were the most important and the most modifiable. The integration of the strengths of both Social Marketing and Intervention Mapping may well improve the effectiveness and sustainability of the resulting intervention and allows integration on multiple levels. Future intervention development studies may provide additional insight into the value of combining complementary methods such as Social Marketing and Intervention Mapping, for instance by expanding the integration of these methods.

During the development, we performed the marketing mix analysis. This analysis enabled us to clarify the most compelling motives of the target segment, the benefits and costs for them to perform the desired behaviour and the target segments' preferences [42]. On the basis of this knowledge, marketing techniques allowed the project team to connect the target behaviour, the value system and the deep motives of the target segment, contributing to a tailored intervention [67, 79]. The fact that key stakeholders at multiple levels were systematically identified and involved in the campaign resulted in bi-directional sharing of knowledge and expertise, co-creation and active participation among partners and stakeholders. Our findings provided further support for the findings of Flynn et al.; they found that the involvement of stakeholders in programme development and implementation appears to increase programme receptivity and acceptance [80]. The mobilization and involvement of stakeholders in combination with

capacity-building strategies is also reflected in the successful EPODE approach as part of its working principles [43]. The follow-up and sustainability of the 'Water Campaign' depended on the results of the evaluation stage. In 2011, the 'Water Campaign' is implemented at two schools as an enrichment of an existing school-based programme 'Enjoy Being Fit!' (EBF)[81].

In **chapter 8**, the effects of the 'Water Campaign' on children's SSB consumption were presented. After one year, we compared children's SSB intake of two schools that continued with their regular health promotion programme (i.e., the EBF programme) with two schools that adopted the 'Water Campaign' in addition to the EBF programme. This controlled trial showed positive effects in reducing the intake of SSB among children by the promotion of the consumption of water (on the basis of two of the three sources of information that were used to assess SSB consumption, i.e., 'parent report' and 'observation report'). Although the intervention had no effect on whether or not children consumed SSB on a daily basis, their average SSB consumption did change: after one year of intervention, on the basis of information gathered using the 'parent report' (administered among parents of children in the grades 3 to 7), both average SSB consumption and average SSB servings were lower in children in the intervention group than in children in the control group. On the basis of information gathered using the 'child report' (administered among children in the grades 5 to 7), no significant differences in average SSB intake (in litres or servings) were found between children in the intervention and control group. An explanation for this discrepancy is lacking, but the lack of effect seen with the 'child report' can most likely be attributed to the fact that children are still too young to properly estimate their behaviour. Children's inability to conceptualize – not only SSB but also the concepts of frequency and averaging – make it debatable whether these young children provide valid responses to food questionnaires that have items covering periods greater than one day [3-5, 82]. In addition, research has shown that parents are more prone to reporting socially desirable answers compared to children [6]. This could also partly explain the fact that SSB consumption reported by children was higher than that reported by parents. The parent-reported SSB consumption is probably more reliable and is supported by similar findings in the observations (children in the grades 2 to 7 were observed). After one year of intervention, the number of children bringing SSB to school was lower in the intervention condition than in the control condition. Although the

observations did not measure total daily SSB consumption, merely what children brought along to school for break-time, they were the most objective measure of SSB consumption in our study. Furthermore, what children bring along to school is most probably largely dependent on their parents' decisions. A number of studies have been published on interventions that aimed to reduce SSB consumption by promoting water. These studies found similar but smaller intervention effects [75-77]. The study of Muckelbauer et al. found a significant increase in water consumption, but no effects on the consumption of juice or soft drinks were observed after adjustment for ethnic background and baseline intake [75]. Compared with these other studies, the intervention effects in our study are thus encouraging. A number of studies have indicated that a reduction in SSB consumption can have beneficial effects on total energy intake and weight status or BMI [69, 70, 74]. However, the fact that we found an effect on SSB consumption does not necessarily imply a decrease in total energy intake or weight gain.

Methodological considerations

There are some methodological considerations that need to be taken into account when interpreting the findings of the discussed studies. All studies, except for the systematic review (chapter 6), were based on data collected in the 'Water Campaign' study. Firstly, methodological considerations with regard to the 'Water Campaign' study will be discussed. Secondly, methodological considerations with regard to the systematic review will be discussed.

The 'Water Campaign' study

Setting and population

The population-based 'Water Campaign' study is a combined school- and community-based intervention on reducing children's SSB consumption by the promotion of water. Four primary schools located in multi-ethnic, disadvantaged neighbourhoods in Rotterdam, the Netherlands, were included in the study. These four schools were randomly allocated to either intervention or control condition. Intervention and control schools were pre-matched in pairs based on number of pupils, socio-economic status and overweight prevalence. The included schools resulted from a convenience sample of schools participating in a municipal overweight intervention programme. All children of

grades 2 to 8 (aged 6 to 13 years old) within each of the four included schools were invited to participate, resulting in a total of 1288 invited children. Passive parental consent was obtained. Parents and children were informed about the study and were free to refuse participation without giving any explanation.

The diverse population with children from various ethnic backgrounds and relatively high response levels on the different measurement types are strengths to be mentioned. Explicitly, the participation rate of parents can be considered as relatively high, given a study in a multi-ethnic, disadvantaged inner-city study area. Given our study sample constitutes of an ethnically diverse sample, which is not representative for the general Dutch population, generalizing our study findings to other populations and settings (e.g., other than multi-ethnic inner-city neighbourhoods) might be difficult. Usually, response rates of higher educated people are higher than in lower educated people in health-related research [83-85]. Because the children of our included schools lived in disadvantaged neighbourhoods of Rotterdam, our participating parents were from a mix of different educational levels.

Missing data

In the 'Water Campaign' study, three main types of measurements were used, i.e., observations, parent and child questionnaires. The observations and child questionnaire were administered at school and data was collected from almost every child (except those children who were absent or of whom was known they or their parents had refused participation). Complete case analyses could be performed for 74.5% of the observations (response rates at baseline 90.8% and at follow-up 76.9%) and for 69.4% of the child questionnaires (response rates at baseline 83.7% and at follow-up 74.7%).

The parent questionnaire was handed out at school by the teachers. Parents had a few weeks to post or hand in the completed questionnaire. A common problem in this kind of studies is the non-response [86, 87]. We undertook several specific actions to increase response of parents on the parent questionnaire (e.g., reminders, allotting family gifts). The response at baseline (54.8%) and at follow-up (61.5%) can be considered to be relatively high given the diversity of our study population from disadvantaged neighbourhoods. However, we could only perform complete case analyses for 34.9% of the parent questionnaires. We conducted non-response analyses for the variables gender,

grade, ethnic background of the child and condition and found indications for selective response (see chapter 8). Therefore, bias may have occurred; the results of the 'Water Campaign' effectiveness study with regard to the parent questionnaire should therefore be interpreted with care.

For each of the studies described in the chapters 2 to 5, a population for analysis was created from the total study sample. These populations for analyses differed due to missing data on the variables of interest and on the type of measurement. Missing data does not necessarily influence the associations under study; however, it does decrease sample size and therefore possibilities to detect subgroup effects [88, 89].

Measurements

Within the 'Water Campaign' study we performed several measurements, namely: (1) observations, (2) parent questionnaires, (3) child questionnaires, and (4) height and weight measurements.

Starting with the latter, to determine the child's BMI and weight status (based on cut-off points published by the International Obesity Task Force [90]), child's height and weight were measured. These measurements were performed by trained personnel applying a national standardized protocol for Youth Health Care [91]. We consider the standardized procedure and specially trained Youth Health Care workers strengths of the height and weight measurements.

Regarding the measurements to gain insight into the health behaviours under study, we consider it a strength to have used three measures – observations, parent questionnaires and child questionnaires – providing insight into the added value of (combining) the various different assessment methods. We recommend future research to always use an objective measure when also using subjective measures. When evaluating the level of agreement between parent-reports and child-reports for child's break-time intake we were unable to indicate the true measure (as described in the study of chapter two). This limited our findings.

Our parent and child questionnaires were provided in Dutch only. Though we pre-tested the questionnaires among a similar population, the language may have been a barrier for some parents or children given the diverse ethnicity of our study population. Although we

provided parents and children with definitions and examples, there may have been some confusion as to what constitutes the different SSB and snack categories. With respect to the questionnaires, we were able to collect data on health behaviours on a daily basis and on average (by means of a continuous measure), which we consider as a strength of this study.

For the studies evaluating the associations of health behaviours – chapters 3, 4 and 5 – parental baseline data of the 'Water Campaign' was used. In these studies we relied on parental self-reports, which is a commonly used way to assess children's intake. Though there is a possibility that parents may have provided socially desirable answers, parent reports are seen as one of the most accurate methods to estimate a child's intake (in the ages 4 to 11 years old)[10]. For the study described in chapter 5, we used validated questionnaires for assessing parenting styles and feeding styles. In all our studies, the Cronbach's alphas indicate 'moderate' to 'good' reliability of the multi-item scales. We recommend further research regarding the validity of these measurement instruments in multi-ethnic populations. Also, these studies have a cross-sectional design, which precludes causal interpretation of our findings. It is recommended to explore and test our findings for causal inferences in longitudinal or experimental studies.

We used definitions of SSB and snacks, which can differ from definitions used in other studies. It may be debatable whether some beverages should be in- or excluded from the definition 'SSB'. In our studies, we defined SSB based on the amount of sugar within the beverages. Still, differences in definition may have limited the comparison of our study findings with those of other researchers.

Evaluation of the effectiveness of the 'Water Campaign'

The main strengths of the evaluation study are the setting and the duration (i.e., activities in daily practice at primary schools and in neighbourhoods for over a year). The study's pragmatic setting means that the effects can be generalized to similar settings. A further strength is that we used all three types of measurements (observations and parent and child questionnaires) to determine the children's SSB consumption.

A limitation of this study is the fact that randomization on the individual level was not possible. Only a limited number of clusters (i.e., four) was possible, which inhibited multi-level analyses which was countered by adding in the analyses a 'school pair' variable (i.e.,

variable indicating the pair of matched schools). As previously mentioned, the use of self-report questionnaires to assess behavioural change is subject to limitations (e.g., misreporting of behaviour and providing socially acceptable answers). We assessed SSB intake 'on average a day' with the parent and child questionnaires and observed SSB consumption 'on a random school day'. Further research is recommended to gain insight into different patterns of the child's SSB consumption (e.g., on week-days vs. weekend-days). Blinding of participants and data collectors was not possible since the 'Water Campaign's' activities were visible at the intervention schools and throughout the neighbourhoods. Further studies may focus on clarifying the possible mechanism underlying this intervention effect, the impact on BMI and the effectiveness in different (ethnic) subgroups. We would also recommend to evaluate the 'Water Campaign' in other settings, using larger samples and longer follow-up periods.

Finally, the 'Water Campaign' consists of several components that promote water consumption. However, when applying such a multi-component intervention, it remains unclear which intervention activities are essential for obtaining the observed effects. We were unable to gather detailed implementation information as it was impossible to register the delivery of components at an individual level. Further research is therefore needed to understand the pathways of the behaviour changes that seem to have occurred.

Systematic review (chapter 6)

Search strategy and study inclusion

A systematic literature review was conducted using multiple literature databases. To identify and select intervention studies, two authors independently reviewed all titles, abstracts and full-text articles. Although we searched several databases to find relevant intervention studies to be included in the review, publication bias may have occurred. Studies that do not show an effect are less frequently published compared to effective interventions. We only included studies published in English spoken, peer-reviewed journals in the past 25 years. As a consequence, studies published in other languages and/or published before 1990 have not been included in our review.

Furthermore, we defined socially disadvantaged children as ethnic minority children and children with a low socio-economic position. It should be acknowledged that although

highly related, ethnic background and family socio-economic position are different, socio-demographic characteristics may likely moderate the associations of risk factors with children's healht behaviours and BMI. To include studies we used cut-off point to reach uniformity in study inclusion. So, to ensure that the study results would be informative for socially disadvantaged children, only studies with a study sample that consisted of at least 50% socially disadvantaged children would be included in our review. Though the cut-off point was based on previous research [92], the cut-off point itself is arbitrary and may have led to the exclusion of potentially informative studies.

Reporting of intervention outcomes

With the exception of one community-based intervention, all interventions were conducted in the (pre)school setting. This made it impossible to draw conclusions regarding differential effects according to the intervention setting. Though we underline the major advantages for the school setting, especially with respect to interventions targeting socially disadvantaged children, we stress the importance for future intervention developers to incorporate family and community components when developing interventions to prevent childhood overweight.

Our review showed that studies were often reluctant to report long-term follow-up measurements of intervention effects, limiting the possibility to draw conclusions on the sustainability of the intervention effects. Finally, a meta-analysis of the results was not possible due to the heterogeneity in study populations, interventions, outcome measures, and statistical analyses.

Recommendations for future research

Study design and measurements

When assessing children's nutritional behaviour, our study showed poor level of agreement between different measurements methods. Therefore, we would recommend the complementary use of objective measurements, observational research and self-report (both parent and child) when investigating children's health behaviours. In addition, research elucidating causal pathways is needed. Further studies may focus on clarifying the possible mechanism underlying the effects found in the 'Water Campaign' evaluation study, the impact on BMI and the effectiveness of the 'Water Campaign' in

different (ethnic) subgroups. It would also be relevant to see whether the positive effects of the 'Water Campaign' on reducing the child's intake of SSB would in time lead to a decrease of childhood overweight.

With respect to the use of Social Marketing, more knowledge on the effectiveness of interventions developed with Social Marketing is needed. For instance through literature-review or meta-analysis. In addition, we would recommend future research to focus on developing an instrument (e.g., checklist or tool) to measure the application of Social Marketing benchmarks. This could help to evaluate the extent to which Social Marketing was used and yield more insight in which Social Marketing benchmarks - or combination thereof - have effect in changing behaviours.

Intervention development and evaluation

We would recommend to evaluate the 'Water Campaign' in other settings, using larger samples and longer follow-up periods. Evaluation of the effects on the long-term is necessary for intervention sustainability. At the moment the 'Water Campaign' is implemented and disseminated nation-wide, in more than 70 cities across the Netherlands as part of the approach JOGG ('Jongeren op Gezond Gewicht', meaning 'Youth at a Healthy Weight').

Interventions are recommend to target both the child and their parents and family to create a healthy family lifestyle. Multiple settings – of which the home environment, schools and community are the most important ones – may be addressed to increase intervention's effectiveness and reach [62]. Also, intervention developers should take into account distinct subgroups within the target audience. Different target segments may ask for different approaches, co-creation, and focus. More insight into determinants of health behaviours of children living in disadvantaged neighbourhoods is needed. Future studies exploring subgroup differences are warranted. This in time may lead to further understanding and identification of the factors that influence health behaviour of different subgroups, so intervention developers and behaviour change agents can use this knowledge to tailor and potentially improve the effectiveness of interventions.

Implications for practice and policy

Use of Social Marketing

The method of Social Marketing challenges intervention developers to choose; to explicitly choose and define the target segment and target behaviour. This focus leads to a tailored intervention specifically aimed at and addressing the specific subgroup, however the intervention might still being implemented for everyone. It should be recommended to not only implement these specific interventions but also the more generic interventions, leading to interventions that reinforce each other's effect.

Policies to stimulate the promotion of healthy behaviours among children living in disadvantaged neighbourhoods

We recommend a thorough evaluation of the implementation and nation-wide dissemination of the 'Water Campaign', as currently is taking place. In addition, the target segment specific insights gained during the development of the 'Water Campaign' could be used to develop other intervention programmes for these target segments in addition to the regular EBF programme, for instance to reduce the child's snack consumption. Because parents serve both as role model and as facilitator impacting children's consumption diet, special attention may be given to intervention activities addressing the parent (family level). As previous research shows as well as the review in chapter 6 describes, interventions targeting multiple health behaviours are found to have a (greater) effect on BMI, while interventions targeting one specific behaviour were effective in changing (only) that behaviour [93, 94]. Expansion of the EBF programme with a campaign reducing the intake of snacks for instance, may further add to effectively reduce the child's BMI.

The 'Water Campaign' is an additional programme to the EBF programme and the campaign can be an additional programme for other interventions aiming to prevent overweight among children. Given most studies identified in our review used only the school-setting, we would recommend to increase the setting-specific activities at the community level. Interventions developers focussing on promoting healthy behaviours may use a combination of settings (i.e., school and community) or levels (individual and family) to increase support from stakeholders and embed local ownership, thereby improving interventions' effectiveness.

General conclusion

This thesis aimed to contribute to the development, implementation and evaluation of interventions aimed to promote healthy behaviours among children living in disadvantaged neighbourhoods. Specifically, the development and effectiveness of the 'Water Campaign', a Social Marketing intervention was described.

The studies in this thesis provide some indications for differences in associations between family and home-related factors and children's health behaviours for children with distinct ethnic backgrounds. Further understanding of the determinants that influence health behaviour of different subgroups (ethnically or culturally diverse) in populations should be gained in future studies, through observational, qualitative and quantitative research. Intervention effectiveness might be improved by identifying the most important determinants of health behaviour for relevant subgroups and consequently, by using these insights to enhance tailoring of the intervention. Intervention developers and behaviour change agents in the field should take relevant differences into account when developing tailored interventions within multi-ethnic communities. However, in all subgroups we found parental determinants to be of great importance (e.g., parental modelling and parenting practices). Parents serve both as role model and as facilitator impacting children's consumption diet. Intervention effectiveness may be improved if also the family level is targeted. In addition, the findings of the review suggest that interventions targeting multiple health behaviours at the same time can have greater effect.

The 'Water Campaign' is a thoroughly developed intervention aimed to prevent childhood overweight by promoting the intake of water and thereby indirectly influencing the child's SSB consumption. The campaign is developed using two different methods, Social Marketing and Intervention Mapping. This resulted in a theory-based and client-oriented intervention for the prevention of overweight among children. The intervention is school- and community-based, directed at multiple levels and systematically involves stakeholders. The resulting integration of the strengths of both Social Marketing and Intervention Mapping might have determined the effectiveness and sustainability of the resulting intervention. The 'Water Campaign' proved to have positive effects on reducing the child's SSB intake. Further studies may focus on clarifying the possible mechanism

underlying these effects, the long-term impact on BMI and the effectiveness in different (ethnic) subgroups. It is also recommended to implement and evaluate the 'Water Campaign' in other settings, using larger samples and longer follow-up periods. This thesis shows in detail how Social Marketing can be used in the development of interventions to prevent childhood overweight, but whether Social Marketing was crucial for the effectiveness of this particular intervention or other interventions in general needs to be further addressed in future research.

References

1. Weber JL, Lytle L, Gittelsohn J, Cunningham-Sabo L, Heller K, Anliker JA *et al.* Validity of self-reported dietary intake at school meals by American Indian children: the Pathways Study. *J Am Diet Assoc* 2004; **104**(5)**:** 746-52.
2. Baranowski T, Dworkin R, Henske JC, Clearman DR, Dunn JK, Nader PR *et al.* The accuracy of children's self-reports of diet: Family Health Project. *J Am Diet Assoc* 1986; **86**(10)**:** 1381-5.
3. McPherson RS, Hoelscher DM, Alexander M, Scanlon KS, Serdula MK. Dietary assessment methods among school-aged children: Validity and reliability. *Prev Med* 2000; **31**(2)**:** S11-S33.
4. Smith AF, Baxter SD, Hardin JW, Guinn CH, Royer JA. Relation of Children's Dietary reporting accuracy to cognitive ability. *Am J Epidemiol* 2011; **173**(1)**:** 103-9.
5. Livingstone MB, Robson PJ. Measurement of dietary intake in children. *Proc Nutr Soc* 2000; **59**(2)**:** 279-93.
6. Bornhorst C, Huybrechts I, Ahrens W, Eiben G, Michels N, Pala V *et al.* Prevalence and determinants of misreporting among European children in proxy-reported 24 h dietary recalls. *Br J Nutr* 2013; **109**(7)**:** 1257-65.
7. Bennett CA, de Silva-Sanigorski AM, Nichols M, Bell AC, Swinburn BA. Assessing the intake of obesity-related foods and beverages in young children: comparison of a simple population survey with 24 hr-recall. *Int J Behav Nutr Phys Act* 2009; **6:** 71.
8. Martins CC, Oliveira MJ, Pordeus IA, Paiva SM. Comparison between observed children's tooth brushing habits and those reported by mothers. *BMC Oral Health* 2011; **11:** 22.
9. Mack KA BJ, Presser S. Measuring and Improving Data Quality in Children's Reports of Dietary Intake. In: Breckenridge R, (ed) *Conference on Health Survey Research Methods*. Colorado, 1995.
10. Burrows TL, Martin RJ, Collins CE. A systematic review of the validity of dietary assessment methods in children when compared with the method of doubly labeled water. *J Am Diet Assoc* 2010; **110**(10)**:** 1501-10.
11. Eck LH, Klesges RC, Hanson CL. Recall of a child's intake from one meal: are parents accurate? *J Am Diet Assoc* 1989; **89**(6)**:** 784-9.
12. Kraemer HC, Measelle JR, Ablow JC, Essex MJ, Boyce WT, Kupfer DJ. A new approach to integrating data from multiple informants in psychiatric assessment and research: mixing and matching contexts and perspectives. *Am J Psychiatry* 2003; **160**(9)**:** 1566-77.
13. Grimm GC, Harnack L, Story M. Factors associated with soft drink consumption in school-aged children. *J Am Diet Assoc* 2004; **104**(8)**:** 1244-9.
14. de Bruijn GJ, Kremers SP, de Vries H, van Mechelen W, Brug J. Associations of social-environmental and individual-level factors with adolescent soft drink consumption: results from the SMILE study. *Health Educ Res* 2007; **22**(2)**:** 227-37.
15. Ezendam NP, Evans AE, Stigler MH, Brug J, Oenema A. Cognitive and home environmental predictors of change in sugar-sweetened beverage consumption among adolescents. *Br J Nutr* 2010; **103**(5)**:** 768-74.

16. 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.

17. 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**(8)**:** 1380-95.

18. 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**(1)**:** 76-80.

19. Verzeletti C, Maes L, Santinello M, Vereecken CA. 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**(3)**:** 312-7.

20. Bauer KW, Neumark-Sztainer D, Fulkerson JA, Hannan PJ, Story M. Familial correlates of adolescent girls' physical activity, television use, dietary intake, weight, and body composition. *Int J Behav Nutr Phys Act* 2011; **8:** 25.

21. van Grieken A, Renders CM, van de Gaar VM, Hirasing RA, Raat H. Associations between the home environment and children's sweet beverage consumption at 2-year follow-up: the 'Be active, eat right' study. *Pediatr Obes* 2015; **10**(2)**:** 126-33.

22. van der Horst K, Oenema A, Ferreira I, Wendel-Vos W, Giskes K, van Lenthe F *et al.* A systematic review of environmental correlates of obesity-related dietary behaviors in youth. *Health Educ Res* 2007; **22**(2)**:** 203-26.

23. Golan M, Crow S. Parents are key players in the prevention and treatment of weight-related problems. *Nutr Rev* 2004; **62**(1)**:** 39-50.

24. Rosenkranz RR, Dzewaltowski DA. Model of the home food environment pertaining to childhood obesity. *Nutr Rev* 2008; **66**(3)**:** 123-40.

25. Van Lippevelde W, te Velde SJ, Verloigne M, De Bourdeaudhuij I, Manios Y, Bere E *et al.* 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**(1)**:** 59-65.

26. Conlon BA, McGinn AP, Lounsbury DW, Diamantis PM, Groisman-Perelstein AE, Wylie-Rosett J *et al.* The Role of Parenting Practices in the Home Environment among Underserved Youth. *Child Obes* 2015; **11**(4)**:** 394-405.

27. De Craemer M, De Decker E, De Bourdeaudhuij I, Vereecken C, Deforche B, Manios Y *et al.* Correlates of energy balance-related behaviours in preschool children: a systematic review. *Obes Rev* 2012; **13 Suppl 1:** 13-28.

28. Mazarello Paes V, Hesketh K, O'Malley C, Moore H, Summerbell C, Griffin S *et al.* Determinants of sugar-sweetened beverages in young children: a systematic review. *Obes Rev* 2015; **16:** 903-913.

29. te Velde SJ, Singh A, Chinapaw M, De Bourdeaudhuij I, Jan N, Kovacs E *et al.* Energy balance related behaviour: personal, home- and friend-related factors among schoolchildren in Europe studied in the ENERGY-project. *PLoS ONE* 2014; **9**(11)**:** e111775.

30. Nierkens V, Hartman MA, Nicolaou M, Vissenberg C, Beune EJ, Hosper K *et al.* Effectiveness of cultural adaptations of interventions aimed at smoking cessation, diet, and/or physical activity in ethnic minorities. a systematic review. *PLoS ONE* 2013; **8**(10)**:** e73373.

31. Bartholomew LK, Parcel GS, Kok G, Gottlieb NH, Fernandez ME. *Planning health promotion programs, an intervention mapping approach*, 3rd edn Jossey-Bass: Francisco, California, 2011.

32. Gubbels JS, Kremers SP, Stafleu A, de Vries SI, Goldbohm RA, Dagnelie PC *et al.* Association between parenting practices and children's dietary intake, activity behavior and development of body mass index: the KOALA Birth Cohort Study. *Int J Behav Nutr Phys Act* 2011; **8:** 18.

33. Pearson N, Ball K, Crawford D. Predictors of changes in adolescents' consumption of fruits, vegetables and energy-dense snacks. *Br J Nutr* 2011; **105**(5)**:** 795-803.

34. van Ansem WJ, Schrijvers CT, Rodenburg G, van de Mheen D. Children's snack consumption: role of parents, peers and child snack-purchasing behaviour. Results from the INPACT study. *Eur J Public Health* 2015; **25**(6)**:** 1006-11.

35. Larson N, Story M. A review of snacking patterns among children and adolescents: what are the implications of snacking for weight status? *Child Obes* 2013; **9**(2)**:** 104-15.

36. van de Gaar VM, Jansen W, van Grieken A, Borsboom G, Kremers S, Raat H. Effects of an intervention aimed at reducing the intake of sugar-sweetened beverages in primary school children: a controlled trial. *Int J Behav Nutr Phys Act* 2014; **11:** 98.

37. 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.

38. Kreuter MW, Lukwago SN, Bucholtz RD, Clark EM, Sanders-Thompson V. Achieving cultural appropriateness in health promotion programs: targeted and tailored approaches. *Health Educ Behav* 2003; **30**(2)**:** 133-46.

39. Doak CM, Visscher TL, Renders CM, Seidell JC. The prevention of overweight and obesity in children and adolescents: a review of interventions and programmes. *Obes Rev* 2006; **7**(1)**:** 111-36.

40. Mauriello LM, Ciavatta MM, Paiva AL, Sherman KJ, Castle PH, Johnson JL *et al.* Results of a multi-media multiple behavior obesity prevention program for adolescents. *Prev Med* 2010; **51**(6)**:** 451-6.

41. Hawkins RP, Kreuter M, Resnicow K, Fishbein M, Dijkstra A. Understanding tailoring in communicating about health. *Health Educ Res* 2008; **23**(3)**:** 454-66.

42. French J, Blair-Stevens C, McVey D, Merritt R. *Social Marketing and Public Health – Theory and Practice*, Oxford University Press: Oxford, 2010.

43. Borys JM, Le Bodo Y, Jebb SA, Seidell JC, Summerbell C, Richard D *et al.* EPODE approach for childhood obesity prevention: methods, progress and international development. *Obes Rev* 2012; **13**(4)**:** 299-315.

44. Taylor NJ, Sahota P, Sargent J, Barber S, Loach J, Louch G *et al.* Using intervention mapping to develop a culturally appropriate intervention to prevent childhood obesity: the HAPPY (Healthy and Active Parenting Programme for Early Years) study. *Int J Behav Nutr Phys Act* 2013; **10:** 142.

45. Blanchette LMG, van de Gaar VM, Raat H, French J, Jansen W. The development of the "Water Campaign": Combining social marketing and intervention mapping. *Journal of Social Marketing* 2016; **6**(4)**:** 16.

46. Paasche-Orlow MK, Wolf MS. The causal pathways linking health literacy to health outcomes. *Am J Health Behav* 2007; **31 Suppl 1:** S19-26.

47. Geboers B, de Winter AF, Luten KA, Jansen CJ, Reijneveld SA. The association of health literacy with physical activity and nutritional behavior in older adults, and its social cognitive mediators. *J Health Commun* 2014; **19 Suppl 2:** 61-76.

48. Speirs KE, Messina LA, Munger AL, Grutzmacher SK. Health literacy and nutrition behaviors among low-income adults. *J Health Care Poor Underserved* 2012; **23**(3)**:** 1082-91.

49. von Wagner C, Knight K, Steptoe A, Wardle J. Functional health literacy and health-promoting behaviour in a national sample of British adults. *J Epidemiol Community Health* 2007; **61**(12)**:** 1086-90.

50. Sanders LM, Federico S, Klass P, Abrams MA, Dreyer B. Literacy and child health: a systematic review. *Arch Pediatr Adolesc Med* 2009; **163**(2)**:** 131-40.

51. Morrison AK, Schapira MM, Gorelick MH, Hoffmann RG, Brousseau DC. Low caregiver health literacy is associated with higher pediatric emergency department use and nonurgent visits. *Acad Pediatr* 2014; **14**(3)**:** 309-14.

52. Morrison AK, Myrvik MP, Brousseau DC, Hoffmann RG, Stanley RM. The relationship between parent health literacy and pediatric emergency department utilization: a systematic review. *Acad Pediatr* 2013; **13**(5)**:** 421-9.

53. Lo K, Cheung C, Lee A, Tam WW, Keung V. Associations between Parental Feeding Styles and Childhood Eating Habits: A Survey of Hong Kong Pre-School Children. *PLoS ONE* 2015; **10**(4)**:** e0124753.

54. Rodenburg G, Kremers SP, Oenema A, van de Mheen D. Associations of parental feeding styles with child snacking behaviour and weight in the context of general parenting. *Public Health Nutr* 2014; **17**(5)**:** 960-9.

55. Sleddens EF, Kremers SP, De Vries NK, Thijs C. Relationship between parental feeding styles and eating behaviours of Dutch children aged 6-7. *Appetite* 2010; **54**(1)**:** 30-6.

56. Lobstein T, Baur L, Uauy R, TaskForce IIO. Obesity in children and young people: a crisis in public health. *Obes Rev* 2004; **5 Suppl 1:** 4-104.

57. Summerbell CD, Waters E, Edmunds LD, Kelly S, Brown T, Campbell KJ. Interventions for preventing obesity in children. *Cochrane Database Syst Rev* 2005; (3)**:** CD001871.

58. Waters E, de Silva-Sanigorski A, Hall BJ, Brown T, Campbell KJ, Gao Y *et al.* Interventions for preventing obesity in children. *Cochrane Database Syst Rev* 2011; (12)**:** CD001871.

59. Galobardes B, Lynch J, Smith GD. Measuring socioeconomic position in health research. *Br Med Bull* 2007; **81-82:** 21-37.

60. Burgi F, Niederer I, Schindler C, Bodenmann P, Marques-Vidal P, Kriemler S *et al.* Effect of a lifestyle intervention on adiposity and fitness in socially disadvantaged subgroups of preschoolers: a cluster-randomized trial (Ballabeina). *Prev Med* 2012; **54**(5)**:** 335-40.

61. de Meij JS, Chinapaw MJ, van Stralen MM, van der Wal MF, van Dieren L, van Mechelen W. Effectiveness of JUMP-in, a Dutch primary school-based community intervention aimed at the promotion of physical activity. *Br J Sports Med* 2011; **45**(13)**:** 1052-7.

62. Bleich SN, Segal J, Wu Y, Wilson R, Wang Y. Systematic review of community-based childhood obesity prevention studies. *Pediatrics* 2013; **132**(1)**:** e201-10.

63. Katz DL, O'Connell M, Njike VY, Yeh MC, Nawaz H. Strategies for the prevention and control of obesity in the school setting: systematic review and meta-analysis. *Int J Obes (Lond)* 2008; **32**(12)**:** 1780-9.

64. Backholer K, Beauchamp A, Ball K, Turrell G, Martin J, Woods J *et al.* A framework for evaluating the impact of obesity prevention strategies on socioeconomic inequalities in weight. *Am J Public Health* 2014; **104**(10)**:** e43-50.

65. Certain LK, Kahn RS. Prevalence, correlates, and trajectory of television viewing among infants and toddlers. *Pediatrics* 2002; **109**(4)**:** 634-42.

66. Garnett BR, Rosenberg KD, Morris DS. Consumption of soda and other sugar-sweetened beverages by 2-year-olds: findings from a population-based survey. *Public Health Nutr* 2013; **16**(10)**:** 1760-7.

67. Stead M, Hastings G, McDermott L. The meaning, effectiveness and future of social marketing. *Obes Rev* 2007; **8 Suppl 1:** 189-93.

68. Barlow SE, Expert C. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics* 2007; **120 Suppl 4:** S164-92.

69. de Ruyter JC, Olthof MR, Seidell JC, Katan MB. A trial of sugar-free or sugar-sweetened beverages and body weight in children. *N Engl J Med* 2012; **367**(15)**:** 1397-406.

70. Ebbeling CB, Feldman HA, Chomitz VR, Antonelli TA, Gortmaker SL, Osganian SK *et al.* A randomized trial of sugar-sweetened beverages and adolescent body weight. *N Engl J Med* 2012; **367**(15)**:** 1407-16.

71. Hu FB. Resolved: there is sufficient scientific evidence that decreasing sugar-sweetened beverage consumption will reduce the prevalence of obesity and obesity-related diseases. *Obes Rev* 2013; **14**(8)**:** 606-19.

72. Swinburn BA, Caterson I, Seidell JC, James WP. Diet, nutrition and the prevention of excess weight gain and obesity. *Public Health Nutr* 2004; **7**(1A)**:** 123-46.

73. Krul C, Blanchette LMG, Jansen W, Meima B. City of Rotterdam: Scoping Enojy Being Fit Family Approach [Scoping Rapport: Gezinsaanpak Lekker Fit!]. In. Rotterdam, the Netherlands: City of Rotterdam, Department of Sports and Culture, 2012.

74. Daniels MC, Popkin BM. Impact of water intake on energy intake and weight status: a systematic review. *Nutr Rev* 2010; **68**(9)**:** 505-21.

75. Muckelbauer R, Libuda L, Clausen K, Toschke AM, Reinehr T, Kersting M. Promotion and provision of drinking water in schools for overweight prevention: randomized, controlled cluster trial. *Pediatrics* 2009; **123**(4)**:** e661-7.

76. Sichieri R, Paula Trotte A, de Souza RA, Veiga GV. School randomised trial on prevention of excessive weight gain by discouraging students from drinking sodas. *Public Health Nutr* 2009; **12**(2)**:** 197-202.

77. Tate DF, Turner-McGrievy G, Lyons E, Stevens J, Erickson K, Polzien K *et al.* Replacing caloric beverages with water or diet beverages for weight loss in adults: main results of the Choose Healthy Options Consciously Everyday (CHOICE) randomized clinical trial. *Am J Clin Nutr* 2012; **95**(3)**:** 555-63.

78. Michale J. Positive And Negative Reinforcement, A Distinction That Is No Longer Necessary; Or A Better Way To Talk About Bad Things. *Journal of Organizational Behavior Management* 2004; **24:** 16.

79. Griffiths J, Blair-Stevens C, Thorpe A. Social Marketing for health and specialised health promotion. In: *World Social Marketing*. Brighton & Hove City, England: National Social Marketing Centre, 2008.

80. Flynn MA, McNeil DA, Maloff B, Mutasingwa D, Wu M, Ford C *et al.* Reducing obesity and related chronic disease risk in children and youth: a synthesis of evidence with 'best practice' recommendations. *Obes Rev* 2006; **7 Suppl 1:** 7-66.

81. Jansen W, Raat H, Zwanenburg EJ, Reuvers I, van Walsem R, Brug J. A school-based intervention to reduce overweight and inactivity in children aged 6-12 years: study design of a randomized controlled trial. *BMC Public Health* 2008; **8:** 257.

82. van de Gaar VM, Jansen W, van der Kleij MJ, Raat H. Do children report differently from their parents and from observed data? Cross-sectional data on fruit, water, sugar-sweetened beverages and break-time foods. *BMC Public Health* 2016; **16:** 341.

83. Berra S, Ravens-Sieberer U, Erhart M, Tebe C, Bisegger C, Duer W *et al.* Methods and representativeness of a European survey in children and adolescents: the KIDSCREEN study. *BMC Public Health* 2007; **7:** 182.

84. Carlsson F, Merlo J, Lindstrom M, Ostergren PO, Lithman T. Representativity of a postal public health questionnaire survey in Sweden, with special reference to ethnic differences in participation. *Scand J Public Health* 2006; **34**(2)**:** 132-9.

85. Mellor JM, Rapoport RB, Maliniak D. The impact of child obesity on active parental consent in school-based survey research on healthy eating and physical activity. *Eval Rev* 2008; **32**(3)**:** 298-312.

86. Alexander CJ, Hwang K, Sipski M. Mothers with spinal cord injuries: Impact on family division of labor, family decision making, and rearing of children. *Top Spinal Cord Inj Rehabil* 2001; **7:** 25-36.

87. Al-Khamees NA. Prevention of home-related injuries of preschoolers: Safety measures taken by mothers. *Health Educ J* 2006; **65**(3)**:** 211-222.

88. Fewtrell MS, Kennedy K, Singhal A, Martin RM, Ness A, Hadders-Algra M *et al.* How much loss to follow-up is acceptable in long-term randomised trials and prospective studies? *Arch Dis Child* 2008; **93**(6)**:** 458-61.

89. Brookes ST, Whitely E, Egger M, Smith GD, Mulheran PA, Peters TJ. Subgroup analyses in randomized trials: risks of subgroup-specific analyses; power and sample size for the interaction test. *J Clin Epidemiol* 2004; **57**(3)**:** 229-36.

90. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000; **320**(7244)**:** 1240-3.

91. Bulk-Bunschoten AMW RC, Leerdam FJM, Hirasing RA. Protocol for detection of overweight in preventive youth health care. *VUMC: Amsterdam* 2004.

92. Kumanyika SK, Swank M, Stachecki J, Whitt-Glover MC, Brennan LK. Examining the evidence for policy and environmental strategies to prevent childhood obesity in black communities: new directions and next steps. *Obes Rev* 2014; **15 Suppl 4:** 177-203.

93. Brown T, Summerbell C. Systematic review of school-based interventions that focus on changing dietary intake and physical activity levels to prevent childhood obesity: an update to the obesity guidance produced by the National Institute for Health and Clinical Excellence. *Obes Rev* 2009; **10**(1)**:** 110-41.

94. Kelishadi R, Azizi-Soleiman F. Controlling childhood obesity: A systematic review on strategies and challenges. *J Res Med Sci* 2014; **19**(10)**:** 993-1008.

Summary / Samenvatting

Summary

Given the high prevalence of unhealthy behaviours and overweight among children – especially the ones living in disadvantaged neighbourhoods – preventive interventions are highly needed. There is a strong call for integrated approaches that bring about effective and sustainable interventions aiming at multiple ecological levels (e.g., individual, family, school, community). The term 'integrated' implies that health promoting interventions simultaneously target individual determinants (e.g., motivation to drink water instead of sugar-sweetened beverages (SSB)) and environmental determinants (e.g., facilitating free tap water points in the neighbourhood). Previous research indicates that these integrated approaches should focus on multiple health behaviours of children (and their family), such as consumption of snacks and SSB, physical activity and play.

A successful example of an integrated approach to support healthy behaviours and prevent overweight is the French EPODE Project ('Ensemble Prévenons l'Obésité Des Enfants', meaning 'Together Let's Prevent Childhood Obesity'). The successes of EPODE were found to be based on several 'pillars' (i.e., effective elements). In the Netherlands, EPODE is translated to JOGG ('Jongeren op Gezond Gewicht', meaning 'Youth at a Healthy Weight'). The organisation behind JOGG strives to realize a society in which all children and young people live, learn, play and work in an environment in which a healthy behaviour is the most natural thing in the world. To gain more insight into the effectiveness of Dutch integrated approaches such as JOGG, a national research consortium was established: Consortium Integrated Approach Overweight (CIAO). The consortium is a collaboration between academic institutions, community health services, local authorities and other relevant sectors ('academic collaborations'). This thesis discusses one of the pillars, namely the use of 'Social Marketing'.

Social Marketing can be defined as: "the adaptation of commercial marketing technologies to programmes designed to influence the voluntary behaviour of target audiences to improve their personal welfare and that of society of which they are a part". The aim of Social Marketing is to achieve voluntary behaviour change by taking the needs and wishes of the target audience as the starting point. The audiences' needs and wishes create understanding on how to best promote the desired behaviour. The use of Social

Marketing in intervention development has led to successful childhood overweight prevention interventions. A major strength of Social Marketing is its 'client-oriented' focus, resulting in tailored interventions, and improved intervention reception and acceptance (i.e., by engaging in dialogue with the audience, the programme will better connect and fit to their world). An example of an intervention which has been developed using Social Marketing is the 'Water Campaign'. Its development and evaluation were described in this thesis.

In three subsequent parts, the following research questions were studied:

For part I: Assessing nutritional behaviour of children

1) How good is the level of agreement between children's report of their own nutritional behaviour compared to reports of their parents and observed data? (chapter 2)

For part II: Determinants of health behaviours among children

2) Which family and home-related factors are associated with health behaviours among children? (chapters 3 & 4)
3) Which parenting styles and parenting feeding styles are associated with health behaviours among children? (chapter 5)

For part III: Development and effect of interventions promoting healthy behaviours among children

4) Which interventions on improving healthy behaviours of disadvantaged children in Europe are effective? (chapter 6)
5) How can Social Marketing be used in intervention development aimed to promote healthy behaviours among children? (chapter 7)
6) How effective is the 'Water Campaign' in reducing the child's SSB intake after one year? (chapter 8)

The first part of this thesis focused on ways to assess nutritional behaviour of children. In **chapter 2**, a study on differences in reporting by children and parents regarding the child's water, fruit and SSB intake was described. In addition, we also described the agreement between observations and child's report of foods brought to school for consumption during break-time. This study showed that children report to consume more sandwiches and snacks during break-time than was observed and that children reported a higher SSB

intake than their parents. Children and parents reported similar estimations of the child's water and fruit consumption. Overall, the level of agreement between the observed break-time foods and that reported by children and the agreement of child's intake between parent and child reports were relatively weak. Future studies should focus on improving methods of evaluating children's consumption behaviour and on ways on how to best use and interpret multiple-source dietary intake data.

The second part of this thesis described studies on determinants of children's health behaviours. In chapters 3 and 4, based on data collected using a parental questionnaire, the influence of family and home-related factors (e.g., parental beliefs, parenting practices) on children's SSB consumption and snack intake was evaluated. In **chapter 3**, we observed that children of parents who have a more positive attitude towards decreasing the child's SSB intake or that children of parents with a more positive subjective norm towards their child's SSB intake, consumed less SSB. Also, children of parents who express healthier parenting practices towards the child's SSB intake (i.e., more restrictive towards the child's SSB consumption) and children of parents who less often model SSB consumption, reported lower SSB intake. We found that children consumed less SSB when there is more SSB available in the home or school environment. This contradicts previous research and our expectations. An explanation might be the cross-sectional design of our study; children who already have high consumption levels might have less SSB available, following already implemented restrictions of their parents trying to improve the child's health.

Chapter 4 provided insight into family and home-related factors related to children's snack consumption in a varied population. We found that children of parents with a more 'favourable' subjective norm towards their child's snack intake, ate less snacks. Also, children of parents who express more 'favourable' parenting practices towards the child's snack intake (i.e., more restrictive towards the child's snack consumption) and children of parents who model snack consumption less often, reported lower snack intake. Our findings from both studies in chapters 3 and 4 emphasize the important role of parents in shaping the child's dietary habits. Parents serve both as role model and as facilitator impacting children's consumption diet. To increase the effectiveness of interventions, parents should be involved or specifically targeted as intervention participants.

The associations described in chapters 3 and 4 were explored within ethnic subgroups. In both studies, we observed differences with respect to the associations between family and home-related factors and children's SSB or snack consumption. Therefore, intervention developers and behaviour change agents in the field may give attention to differences between subgroups when developing tailored interventions within multi-ethnic communities.

In **chapter 5**, we investigated the relationship between feeding styles, parenting styles and the child's snack consumption. Overall, we found that children whose parents express more 'control over eating' less often consumed more than one unhealthy snack per day. Similar to our findings of chapters 3 and 4, we found that these associations differed for children with distinct ethnic backgrounds.

In the third part of this thesis, we described studies on the development and effectiveness of interventions aimed at promoting a healthy behaviour among children. In **chapter 6**, a systematic review described the evidence on the effectiveness of interventions aimed to improve healthy behaviours and/or prevent overweight among 0 to 12 year old socially disadvantaged children in Europe. In general, we found that interventions targeting multiple health behaviours were moderately effective in positively influencing weight status and/or Body Mass Index (BMI), while interventions targeting one specific behaviour were moderately effective in changing that behaviour but neither weight status nor BMI. Results from this systematic review showed that few studies have investigated the effects of such interventions among socially disadvantaged children and even fewer studies have shown substantial and sustained effects.

Chapters 7 and 8 describe the development and evaluation of the 'Water Campaign'. **Chapter 7** described how the 'Water Campaign' is developed. The 'Water Campaign', an enrichment of an existing school-based programme 'Enjoy Being Fit!' (EBF), was developed using Social Marketing in combination with Intervention Mapping (i.e., a systematic method to develop health promotion interventions). Following the Social Marketing total process planning framework, we first conducted an extensive scoping stage (e.g., using among others desk research and focus-group interviews) to identify specific target segments and target behaviours. The Intervention Mapping tools helped to select the most important and modifiable determinants in the target segments, as well

as to select and appropriately apply theoretical methods for influencing determinants and effectuate behaviour change. The integration resulted in a combination of the strengths of both methods (i.e., theory-based and client-oriented).

The resulting 'Water Campaign' was aimed at Moroccan and Turkish mothers and their 6 to 12 year old children (i.e., target segment). This intervention aims to reduce the consumption of SSB through the promotion of tap water drinking (i.e., target behaviour). The systematic involvement of key stakeholders resulted in capacity-building and co-creation. In 2011, the campaign was implemented in two multi-ethnic, disadvantaged neighbourhoods in Rotterdam, the Netherlands. The campaign targeted both children and their parents (primarily mothers) through activities at school and in the neighbourhood. Although the intervention was tailored to, pre-tested with and developed for children and mothers from these ethnic minorities, the 'Water Campaign' was delivered to all children (and their families) attending schools in and/or living in the two 'Water Campaign' neighbourhoods.

In **chapter 8**, the effects of the 'Water Campaign' on children's SSB consumption were evaluated. To gain insight into the children's SSB intake, we conducted among all children in grades 3 to 8 observations at school and their parents completed questionnaires. In addition, children in grades 6 to 8 completed questionnaires. After one year, we compared children's SSB intake of two 'control schools' that continued with their regular health promotion programme (i.e., the EBF programme) with two 'intervention schools' that adopted the 'Water Campaign' in addition to the EBF programme. Our study showed positive effects of the 'Water Campaign' in reducing the intake of SSB among children when promoting the consumption of water: after one year, children attending the intervention schools consumed significantly less SSB compared to the children attending the control schools (based on the observations at school and the parental reports).

Chapter 9 included a general discussion, including a description and interpretation of the main findings, methodological considerations, implications for policy and practice, and recommendations for future research.

To conclude, the studies in this thesis provide some indications for various associations between determinants and health behaviour of the child, with an important role for parent-related factors. In addition, these relationships appear to be different for children

with distinct ethnic backgrounds. Further research – observational, qualitative and quantitative research – is recommended to obtain insights on these differences in associations for children with distinct ethnic backgrounds. Intervention developers and health promoters might give special attention to relevant differences between various subgroups when developing tailored interventions within multi-ethnic communities. In addition, the findings of the review suggest that interventions targeting multiple health behaviours can have greater effect.

This thesis describes the 'Water Campaign' intervention. An intervention developed using Social Marketing and Intervention Mapping, where the integration of the strengths of both methods might have determined the effectiveness and sustainability of the resulting intervention. The 'Water Campaign' proved to have positive effects on reducing the child's SSB intake. Further studies may focus on clarifying the possible mechanism underlying these effects, the long-term impact on weight status and/or BMI and the effectiveness within (ethnic) subgroups.

Samenvatting

Gezien de hoge prevalentie van ongezond gedrag en overgewicht bij kinderen – vooral bij degenen uit achterstandswijken – zijn preventieve interventies noodzakelijk. Er is een sterke roep om integrale aanpakken die leiden tot effectieve en duurzame interventies gericht op verschillende ecologische niveaus (bijv. individueel, familie, school, wijk). De term 'integraal' impliceert gezondheidsbevorderende interventies die tegelijkertijd gericht zijn op individuele determinanten (bijv. de motivatie om water in plaats van gezoete dranken (ZD) te drinken) en op omgevingsfactoren (bijv. de aanwezigheid van meerdere gratis watertappunten in de wijk). Eerder onderzoek geeft aan dat deze integrale aanpakken gericht moeten zijn op meerdere gezonde gedragingen van kinderen (en hun familie), zoals het verminderen van snacks en ZD consumptie, en het stimuleren van lichamelijke activiteit en (buiten) spelen.

Een succesvol voorbeeld van een integrale aanpak om een gezonde levensstijl te bevorderen en overgewicht bij kinderen te voorkomen is het Franse EPODE Project ('Ensemble Prévenons l'Obésité Des Enfants', wat betekent 'laten we samen overgewicht bij kinderen voorkomen'). De successen van EPODE bleken gefundeerd te zijn op basis van diverse 'pijlers' (effectieve elementen). In Nederland is EPODE vertaald naar JOGG (Jongeren op Gezond Gewicht). JOGG streeft naar een samenleving waarin alle kinderen en jongeren wonen, leren, spelen en werken in een omgeving waarin een gezonde levensstijl de gewoonste zaak van de wereld is. Om in Nederland de effectiviteit te evalueren van integrale aanpakken zoals JOGG, is een nationaal onderzoek consortium opgericht: Consortium Integrale Aanpak Overgewicht (CIAO). Het consortium is een samenwerking tussen academische instellingen, publieke en gemeentelijke gezondheidsdiensten (GGD'en), lokale overheden en andere relevante sectoren ('academische werkplaatsen'). In dit proefschrift komt een van de pijlers aan bod, namelijk het gebruik van 'Sociale Marketing'.

Sociale Marketing kan worden gedefinieerd als: "de toepassing van commerciële marketing technologieën om programma's te ontwikkelen die vrijwillige gedragsverandering realiseren met als doel het verbeteren van het persoonlijk welzijn en die van de samenleving". Het doel van Sociale Marketing is vrijwillige gedragsverandering

te bereiken door de behoeften en wensen van de doelgroep als uitgangspunt te nemen. Met behulp van deze inzichten van de doelgroep kunnen de beste interventies ontwikkel worden om het gewenste gedrag te bevorderen. Het gebruik van Sociale Marketing binnen interventie ontwikkeling heeft geleid tot diverse succesvolle interventies gericht op preventie van overgewicht bij kinderen. Een grote kracht van Sociale Marketing is de 'klantgerichtheid', wat resulteert in op maat gesneden interventies en verbeterde interventie ontvangst en acceptatie (d.w.z. door het aangaan van een dialoog met de doelgroep, zal de interventie beter met hun wereld te verbinden en in te passen zijn). Een voorbeeld van een interventie die is ontwikkeld met behulp van Sociale Marketing is de 'Water Campagne'. De ontwikkeling en evaluatie van deze campagne zijn beschreven in dit proefschrift. In drie opeenvolgende onderdelen werden de volgende onderzoeksvragen bestudeerd:

Voor deel I: Het beoordelen van eet- en drinkgewoonten van kinderen

1) Hoe goed is de mate van overeenstemming tussen wat kinderen zelf rapporteren over hun eet- en drinkgewoonten vergeleken met wat hun ouders rapporteren en vergeleken met wat geobserveerd is? (hoofdstuk 2)

Voor deel II: Determinanten van gezond gedrag bij kinderen

2) Welke determinanten worden in verband gebracht met gezond gedrag bij kinderen? (hoofdstukken 3 & 4)
3) Welke voedingsstijlen en opvoedingsstijlen hangen samen met gezond gedrag bij kinderen? (hoofdstuk 5)

Voor Deel III: Ontwikkeling en evaluatie van interventies die gezond gedrag bij kinderen bevorderen

4) Welke interventies gericht op het verbeteren van gezond gedrag van sociaal achtergestelde kinderen in Europa zijn effectief? (hoofdstuk 6)
5) Hoe kan Sociale Marketing worden gebruikt in interventie ontwikkeling gericht op het bevorderen van gezond gedrag bij kinderen? (hoofdstuk 7)
6) Hoe effectief is het 'Water Campagne' na een jaar in het verminderen van ZD bij kinderen? (hoofdstuk 8)

Het eerste deel van dit proefschrift richtte zich op manieren om de eet- en drinkgewoonten van kinderen te meten. Het onderzoek in **hoofdstuk 2** beschreef de

verschillen in rapporten tussen kinderen en hun ouders over de inname van water, fruit en ZD door het kind. Daarnaast werd gekeken naar de overeenkomsten tussen observaties en wat kinderen rapporteerden betreffende de inname tijdens de ochtendpauze op school. Deze studie toonde aan dat kinderen rapporteerden meer broodjes en snacks te eten tijdens de pauze dan werd waargenomen en dat kinderen een hogere ZD inname rapporteerden dan hun ouders. Kinderen en ouders rapporteerden soortgelijke hoeveelheden van water en fruit consumptie door het kind. Over het algemeen was de mate van overeenstemming relatief zwak, zowel tussen wat ouders en kinderen rapporteerden als tussen wat kinderen rapporteerden en geobserveerd was. Toekomstig onderzoek moet zich richten op het verbeteren van methoden voor het meten van eet- en drinkgewoonten van kinderen en op manieren hoe gegevens van meerdere bronnen te combineren en interpreteren.

Het tweede deel van dit proefschrift beschreef studies naar determinanten van gezond gedrag van kinderen. In de hoofdstukken 3 en 4, is de invloed van determinanten (bijv. voorbeeldgedrag van ouders of eet- en drinkregels in huis) op de inname van ZD en snacks door kinderen geëvalueerd. Hiervoor werden gegevens verzameld met behulp van een vragenlijst onder ouders. In **hoofdstuk 3** zagen we onder andere dat kinderen minder ZD dronken als ouders een meer positieve houding hebben ten aanzien van het verminderen van de ZD inname door het kind. Een ander voorbeeld van wat we in deze studie vonden, is dat kinderen van ouders die zelf minder ZD drinken in het bijzijn van het kind, minder ZD dronken. We vonden ook dat kinderen minder ZD dronken wanneer er meer ZD beschikbaar waren. Dit is in tegenspraak met eerdere onderzoeken en onze verwachtingen. Een mogelijke verklaring kan zijn de opzet van onze studie met slechts één meet-moment; ouders van kinderen die al (te) veel ZD dronken, hebben misschien reeds actie ondernomen en minder of geen ZD in huis halen. **Hoofdstuk 4** beschreef de studie naar determinanten die verband houden met de snackconsumptie van kinderen. We vonden onder andere dat kinderen minder snacks aten als ouders vaker gezondere ouderschapspraktijken uitten jegens snack inname van het kind (d.w.z. meer restrictiever zijn richting de snackconsumptie van het kind). Onze bevindingen van beide onderzoeken in de hoofdstukken 3 en 4 onderstrepen de belangrijke rol van ouders in het vormgeven van eet- en drinkgewoonten van kinderen. Ouders zijn zowel rolmodel als facilitator. Om de effectiviteit van interventies gericht op het promoten van gezond gedrag te vergroten,

moeten interventie ontwikkelaars zich naast kinderen ook op ouders richten als doelgroep van interventies. De in de hoofdstukken 3 en 4 beschreven studies naar associaties werden onderzocht binnen een multi-etnische populatie. In beide studies zagen we verschillen voor diverse etnische subgroepen met betrekking tot de gevonden verbanden tussen determinanten en de ZD en snack inname van het kind. Kennis van deze verschillen – welke factoren belangrijk zijn voor welke subgroep – kan interventie ontwikkelaars en gezondheidsbevorderaars helpen bij het ontwikkelen van op maat gesneden interventies binnen multi-etnische doelgroepen.

In **hoofdstuk 5** onderzochten we de relatie tussen voedingsstijlen, opvoedingsstijlen en de snackgewoonten van het kind. We vonden onder meer dat kinderen van wie de ouders die hoger scoorden op 'controle hebben over het eten van mijn kind', minder vaak meer dan één ongezonde snack per dag aten. Vergelijkbaar met de bevindingen in hoofdstukken 3 en 4, bleek dat deze associaties anders zijn voor kinderen met verschillende etnische achtergronden.

In het derde deel van dit proefschrift beschreven we studies over de ontwikkeling en effectiviteit van interventies gericht op het bevorderen van gezond gedrag bij kinderen. **Hoofdstuk 6** betrof een systematisch review naar de effectiviteit van interventies gericht op het bevorderen van gezonde gedragingen en/of preventie van overgewicht bij sociaal achtergestelde kinderen (0 t/m 12 jaar) in Europa. Interventies gericht op meerdere gezonde gedragingen bleken matig effectief in het positief beïnvloeden van overgewicht, terwijl interventies gericht op één specifiek gezond gedrag matig effectief bleken in het veranderen van dat specifieke gezonde gedrag (maar niet overgewicht). Verder laten de resultaten van deze review zien dat effect evaluaties bij sociaal achtergestelde kinderen schaars zijn en dat de effecten over het algemeen bescheiden zijn.

Hoofdstuk 7 en 8 beschreven de ontwikkeling en evaluatie van de 'Water Campagne'. **Hoofdstuk 7** beschreef hoe de 'Water Campagne' is ontwikkeld. De 'Water Campagne', een verrijking van een bestaande schoolprogramma 'Lekker Fit!' (LF), werd ontwikkeld met behulp van Sociale Marketing in combinatie met Intervention Mapping (een systematische methode om gezondheidsbevorderende interventies te ontwikkelen). Om specifieke doelgroepen en doelgedragingen te identificeren werd een uitgebreide 'scopingfase' uitgevoerd (o.a. d.m.v. bureau-onderzoek en focus groep interviews). De

Intervention Mapping instrumenten hebben geholpen om de belangrijkste en meest beïnvloedbare determinanten te selecteren en tevens ook om de juiste theoretische methoden te selecteren voor het bereiken van de gewenste gedragsverandering. De integratie van beide methoden resulteerde in een combinatie van de sterke punten (d.w.z. gefundeerd vanuit theorie en klantgericht).

De resulterende 'Water Campagne' was gericht op Marokkaanse en Turkse moeders en hun 6 t/m 12 jarige kinderen (doelgroep). Deze interventie richt zich op het verminderen van de consumptie van ZD door water drinken te bevorderen (doelgedrag). De systematische betrokkenheid van de voornaamste belanghebbenden resulteerde in co-creatie en mede-eigenaarschap. In 2011 werd de campagne geïmplementeerd in twee multi-etnische, achterstandswijken in Rotterdam. De campagne richt zich zowel op kinderen als hun ouders (vooral moeders) door middel van activiteiten op school en in de wijk. Hoewel de interventie ontwikkeld is voor kinderen en moeders met een Marokkaanse of Turkse herkomst, is de 'Water Campagne' voor alle kinderen (en hun families) die naar school gaan of wonen in de twee 'Water Campagne' wijken.

In **hoofdstuk 8** werden de effecten van de 'Water Campagne' op de ZD inname van de kinderen onderzocht. De effectiviteit van de 'Water Campagne' werd bepaald door na één jaar de ZD inname van kinderen van twee 'controle scholen' – die enkel hun reguliere programma voor gezondheidsbevordering uitvoerden (het LF programma) – te vergelijken met de ZD inname van kinderen van twee 'interventie scholen' – die de 'Water Campagne' in aanvulling op het LF programma uitvoerde. Om inzicht te krijgen in de ZD consumptie van kinderen, werden alle kinderen in de groepen 3 t/m 8 geobserveerd en hun ouders benaderd om vragenlijsten in te vullen. Ook vulden alle kinderen in de bovenbouw (groepen 6 t/m 8) vragenlijsten in. Onze studie toonde positieve effecten van de 'Water Campagne' aan betreffende het verminderen van de inname van ZD door kinderen: enkel door het bevorderen van het drinken van water dronken de kinderen van de interventie scholen na één jaar aanzienlijk minder ZD in vergelijking met de kinderen van de controle scholen (deze bevindingen zijn gebaseerd op gegevens uit de observaties en de ouder vragenlijsten).

Hoofdstuk 9 bestaat uit een algemene discussie, inclusief een beschrijving en interpretatie van de hoofdbevindingen, methodologische overwegingen, implicaties voor beleid en praktijk, en aanbevelingen voor toekomstig onderzoek.

Tot slot, de studies in dit proefschrift bieden een aantal aanwijzingen voor diverse associaties na determinanten en gezond gedrag bij kinderen, met een belangrijke rol voor ouder-gerelateerde factoren. Daarbij blijken de verbanden te verschillen voor kinderen met diverse etnische achtergronden. Voor toekomstig onderzoek – door middel van observationeel, kwalitatief en kwantitatief onderzoek – is aan te bevelen om inzichten te verkrijgen betreffende deze verschillen in associaties voor kinderen met diverse etnische achtergronden. Interventie ontwikkelaars en gezondheidsbevorderaars zouden speciale aandacht kunnen geven aan relevante verschillen tussen diverse subgroepen bij het ontwikkelen van op maat gesneden interventies binnen multi-etnische populaties. De bevindingen uit de review suggereren dat interventies gericht op meerdere gezonde gedragingen een groter effect kunnen hebben.

In dit proefschrift staat de 'Water Campagne' interventie beschreven. Een interventie ontwikkeld met behulp van Sociale Marketing en Intervention Mapping, waarbij de integratie van sterkte punten van beide methoden wellicht de effectiviteit en duurzaamheid van de daaruit voortvloeiende interventie heeft medebepaald. De 'Water Campagne' bleek een positief effect te hebben op het verminderen van de ZD inname van het kind. Toekomstige studies kunnen zich richten op mogelijke mechanismen die deze effecten kunnen verduidelijken, op lange termijn effecten op (over)gewicht en op de effectiviteit binnen verschillende (etnische) subgroepen.

Dankwoord

Curriculum Vitae

List of publications

PhD portfolio

Dankwoord

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Curriculum vitae

Vivian Kruitwagen - van de Gaar was born on April 5th 1985 in Heerlen, the Netherlands. In 2003, she completed high school at College Rolduc in Kerkrade. In the same year, she started her study Health Sciences at Maastricht University. In 2010, she obtained her Master degree in Health Education and Promotion. Following her Master degree, she started her PhD project at the Department of Public Health at the Erasmus Medical Center in Rotterdam, the Netherlands, the results of which are presented in this thesis. In 2013, as part of her PhD programme, she obtained a second Master degree in Epidemiology at the National Institute for Health Sciences (NIHES) in Rotterdam.

Currently, Vivian is working at The Dutch National Institute for Public Health and the Environment (RIVM), *Centre for Healthy Living* on the programme 'Healthy Schools' (Gezonde School).

List of publications

2017

Van de Gaar VM, van Grieken A, Jansen W, Raat H. Children's sugar-sweetened beverages consumption: Associations with family and home-related factors, differences within ethnic groups explored. *BMC Public Health*. 2017; 17:195

Wijtzes AI, **van de Gaar VM**, van Grieken A, de Kroon MLA, Mackenbach JP, van Lenthe FJ, Jansen W, Raat H. Effectiveness of interventions to improve lifestyle behaviours among socially disadvantaged children in. *European Journal of Public Health*. 2017; 27 (2): 240-247

2016

Van de Gaar VM, Blanchette LMG, Raat H, French J, Jansen W. The development of the 'Water Campaign': Combining Social Marketing and Intervention Mapping. *Journal of Social Marketing*. 2016; 6(4), 318-334

Van de Gaar VM, Jansen W, van der Kleij MJJ, Raat H. Do children report differently from their parents and from observed data? Cross-sectional data on fruit, water, sugar-sweetened beverages and break-time foods. *BMC Public Health*. 2016; 16:341

2015

Van de Gaar VM, Blanchette LMG, Krul C. The 'Water Campaign' Rotterdam (chapter 13). In: *Strategic Social Marketing. Embedding Social Marketing in Social Programmes*. French J and Ross G, April 2015

Van Grieken A, Renders CM, **van de Gaar VM**, Hirasing RA, Raat H. Associations between the home environment and children's sweet beverage consumption at 2-year follow-up: the 'Be active, eat right' study. *Pediatric Obesity*. 2015; 10(2), 126-33

Van der Kleij MJJ, Crone MR, Paulussen TGWM, **van de Gaar VM**, Reis R. A stitch in time saves nine? A repeated cross-sectional case study on the implementation of the intersectoral community approach Youth At a Healthy Weight. *BMC Public Health*. 2015; 15:1032

2014

Van de Gaar VM, Jansen W, van Grieken A, Borsboom GJJM, Kremers S, Raat H. Effects of an intervention aimed at reducing the intake of sugar-sweetened beverages in primary school children: a controlled trial. *International Journal of Behavioural Nutrition and Physical Activity*. 2014; 11:98

> This article has also been included as chapter 12 in the book: *The Childhood Obesity Epidemic: Why Are Our Children Obese and What Can We Do About It?* Vash P.D., March 2015

Van Koperen TM, van der Kleij MJJ, Renders CM, Crone MR, Hendriks AM, Jansen MM, **van de Gaar VM**, Raat H, Ruiter ELM, Molleman GRM, Schuit AJ, Seidell JC. Design of CIAO, a research program to support the development of an integrated approach to prevent overweight and obesity in the Netherlands. *BMC Obesity*. 2014; 1:5

2013

Meertens RM, **van de Gaar VM**, Spronken M, de Vries NK. Prevention praised, cure preferred: results of between-subjects experimental studies comparing (monetary) appreciation for preventive and curative interventions. *BMC Medical Informatics and Decision Making*. 2013; 13:136

Submitted for publication

Van de Gaar VM, van Grieken A, Jansen W, Raat H. Associations between family and home-related factors and child's snack consumption, differences within ethnic groups explored

Wang L, **van de Gaar VM**, Jansen W, Mieloo CL, van Grieken A, Raat H. Feeding styles, parenting styles and snacking behaviour in school-aged children: findings from a multi-ethnic population

PhD portfolio

Name PhD student:	Vivian M.J. Kruitwagen - van de Gaar
Erasmus MC Department:	Public Health
Research School:	Netherlands Institute for Health Sciences (NIHES)
PhD period:	January 2011 – April 2015
Promotors:	Prof.dr. H. Raat
Copromotor:	Dr.ir. W. Jansen

PhD training, teaching activities, and other activities	Year	Workload (ECTS)
1. PhD training		
Master degree Health Sciences, specialization Epidemiology, NIHES, Erasmus University Rotterdam, the Netherlands		
Principles of Research in Medicine	2011	0.7
Methods of Public Health Research	2011	0.7
Conceptual Foundation of Epidemiologic Study Design	2011	0.7
Introduction to Global Public Health	2011	0.7
Primary and Secondary Prevention Research	2011	0.7
Health Economics	2011	0.7
Study Design	2011	4.3
Methodological Topics in Epidemiologic Research	2011	1.4
Public Health Research	2011	5.7
Environmental Epidemiology	2011	1.1
Courses for the Quantitative Researcher	2011	1.4
Social Epidemiology	2012	0.7
Causal Inference	2012	0.7
Markers and Prognostic Research	2012	0.7
History of Epidemiologic ideas	2012	0.7
Biostatistical Methods I: Classical Methods for Data-analysis	2012	5.7
Biostatistical Methods II: Classical Regression Models	2012	4.3
Maternal and Child Health	2012	0.9
Ethnicity, Health and Health Care	2012	1.1
Women's Health	2013	0.9

PhD training, teaching activities, and other activities	Year	Workload (ECTS)
Post-Graduate Certificate Social Marketing, Brighton Business School, University of Brighton, United Kingdom		
Module Social Marketing	2012	10.0
Extracurricular courses, Erasmus University Rotterdam/Erasmus Medical Centre (MC) Rotterdam, the Netherlands		
Course English Biomedical Writing and Communication	2013	4.0
Course how to use Endnote (Medical Library)	2013	0.2
Systematic Literature Search in PubMed (Medical Library)	2013	0.2
Cursus Wetenschappelijke Integriteit	2014	0.3
Project Management in Research	2015	0.3
Seminars and workshops		
Seminars Department of Public Health, Erasmus MC, the Netherlands	2010-2014	1.0
Seminars Department of Public Health, Section Youth Health Care, Erasmus MC, the Netherlands	2010-2014	1.0
Seminars CEPHIR, Rotterdam, the Netherlands	2010-2014	0.2
Seminars and workshops Consortium Integrated Approach Overweight (CIAO), the Netherlands	2010-2015	1.0
Pre-conference meeting International Society of Behavioral Nutrition and Physical Activity (ISBNPA),Houston, United States of America	2012	0.7
(Inter)national conferences and presentations		
Consortium Integrated Approach Overweight (CIAO), multiple locations (oral)	2010-2015	0.7
Nederlands Congres Volksgezondheid (NCVGZ), Amsterdam (poster)	2011	0.7
Pre-conference meeting International Society of Behavioral Nutrition and Physical Activity (ISBNPA),Houston, United States of America (poster)	2012	0.7
11th International Society of Behavioral Nutrition and Physical Activity (ISBNPA), Austin, Texas, United States of America (poster)	2012	0.7
Nederlands Congres Volksgezondheid (NCVGZ), Rotterdam (oral)	2013	0.7
World Social Marketing Conference, Toronto, Canada (poster; award 1st student prize)	2013	0.7
Nederlands Congres Volksgezondheid (NCVGZ), Rotterdam (oral)	2014	0.7

PhD training, teaching activities, and other activities	Year	Workload (ECTS)
2. Teaching activities		
Supervision of Master student 'Health Sciences' VU University	2011-2012	4.0
Supervision of Bachelor students for the course 'Community Projects'	2011-2014	1.0
3. Other activities		
Application Medical Ethical Committee, the 'Water Campaign' study	2010	3.0
Collaborating Researcher CIAO (Consortium Integrated Approach Overweight)	2010-2014	4.0
Peer review for International Society of Behavioral Nutrition and Physical Activity and Journal of Social Marketing	2011-2014	1.0
Co-hosting 'Café Local' on Social Marketing, Rotterdam, the Netherlands	2012	1.0
Co-hosting 'CIAO voor jou! Verbinden & versterken' symposium, Utrecht, the Netherlands	2012	1.0
Researcher 'Klein maar Fijn', CEPHIR, Rotterdam, the Netherlands	2012-2013	1.0