Home environmental influences on adolescents' energy balance related behaviours

The HEIA cohort study

Torunn Holm Totland

PHD Thesis at the Faculty of Medicine

UNIVERSITY OF OSLO

Oslo 2013

HOME ENVIRONMENTAL INFLUENCES ON ADOLESCENTS' ENERGY BALANCE RELATED BEHAVIOURS: THE HEIA COHORT STUDY

TORUNN HOLM TOTLAND

Department of Nutrition
Institute of Basic Medical Sciences
Faculty of Medicine
University of Oslo

UiO : University of Oslo

SUMMARY

The global obesity epidemic represents an enormous potential threat to public health, because overweight and obesity are major risk factors of non-communicable diseases. The prevalence of overweight has furthermore increased among children and adolescents worldwide, and creates a growing health challenge for the next generation as children who are overweight are more likely to become overweight and obese as adults. Dietary, physical activity and sedentary behaviours are energy balance related behaviours (EBRB) that positively or negatively are related to weight status. It is agreed upon that the obesity epidemic is driven by large environmental changes over the past few decades, negatively influencing the EBRB. Social inequalities are furthermore consistently observed in children's and adolescents' weight status and health behaviours. Thus, there is a need for research to identify environmental factors influencing children's and adolescents EBRB across age and within diverse social groups, in order to establish good opportunities of a healthy future. The main aims of this thesis were first to investigate the changes and tracking in children's dietary behaviours during the transition into adolescence, and possible differences by parental education. Second to examine how the home environment influences young adolescents' dietary and sedentary behaviours between the ages of 11 and 13 years, including social differences as measured by parental education.

Longitudinal data from the Norwegian HEalth In Adolescents (HEIA) cohort study (2007–09) is included. Data was collected through questionnaires among a baseline sample of 975 adolescents at the age of 11 years (T0), and followed up at age 12 (T1) and 13 (T2) years. Furthermore, questionnaires were collected from both mothers (n=738) and fathers (n=630) at T0, and followed up at T2. Dietary intakes of fruits, vegetables, energy dense snacks, sugar sweetened soft drinks and sugar sweetened squash were examined prospectively, as well as screen time behaviours of television and video viewing (TV/DVD), and computer and electronic game use (PC/game). Parental education, parental modelling, parental regulation, availability and accessibility were explored as possible determinants in the home environment. Analyses of tracking was used to investigate changes and stability in dietary behaviours over time, and mediation analyses explored possible influences of the home environment on adolescents' prospective soft drink intake and screen time.

Tracking of the frequency of fruit, vegetable and snack intake, and in the amount of soft drinks and squash consumption was observed among boys and girls between the ages of 11 and 13 years. The intake of soft drinks did furthermore increase significantly during this time period. An inverse association was found between level of parental education and tracking in adolescents' soft drink and squash consumption, as higher odds of a stable low than a stable high intake of soft drinks and squash was observed among those with a higher level of parental education. A higher level of parental education did furthermore predict a lower intake of soft drinks at the age of 13 years. A higher availability and accessibility of soft drinks at home subsequently predicted an increased intake among adolescents between the ages of 11 and 13 years. Moreover, the relationship of parental education predicting adolescents' soft drink intake was explained trough the accessibility of soft drinks at home, identified as a mediating factor. In addition, a higher level of parental education predicted less time spent on PC/games among 13 year olds. A positive relationship was observed between parental modelling and adolescents' TV/DVD time and an inverse relationship between parental regulation and adolescents' TV/DVD time was subsequently found between the ages of 11 and 13 years. Finally, maternal and paternal modelling of TV/DVD viewing were found to mediate the relationship of parental education predicting adolescents' TV/DVD time at the age of 13 years.

The present study contributes to international research by enhancing the understanding of children's and adolescents' dietary and sedentary behaviours in a longitudinal perspective. The findings indicate tracking of dietary behaviours between the ages of 11 and 13 years, and thus emphasize the importance of starting before the age of 11 years to prevent the establishment of unfavourable dietary behaviours later in adolescence. Moreover, the parental role in adolescents' dietary and screen time behaviours is highlighted through availability and accessibility in the home, parental modelling and regulation by implying that raising awareness of these determinants may result in a healthier lifestyle which further can influence weight status. Finally, the present analyses emphasize differences by parental education in adolescents' dietary and screen time behaviours which could contribute to social inequalities in health. The accessibility of soft drinks at home and parental modelling of TV/DVD time was identified as important targets in future health education and health promotion programs aiming to reduce social differences in such health behaviours among adolescents.

ACKNOWLEDGEMENTS

The journey through a PhD degree seems long, although the time period of three years feels very short along the way. A numerous of individuals, groups and institutions have been involved through my time as a PhD student, contributing with resources, supervision, experience, support and/or encouragement. I am greatly thankful for each of you, of which I would like to share my gratitude's.

The HEIA study was initiated by Knut-Inge Klepp in 2005, and data collection was carried out in 2007-09 as a collaboration between the Norwegian School of Sport Sciences and the University of Oslo. First of all I would like to thank every participant and parent taking part in the HEIA study, this work could not have been done without you! Furthermore, I would like to express my gratefulness to the HEIA consortium and my co-authors for including me in this research, for valuable contributions and support throughout this period.

The HEIA study was originally funded by the Norwegian Research Council with supplementary funds from the Throne Holst Nutrition Research Foundation and the Norwegian School of Sport Sciences. The work of the present thesis was initiated in 2009, and financed through the National Association of Public Health with aid of EXTRA by the Norwegian Extra Foundation for Health and Rehabilitation since 2010. I highly appreciate the opportunity of spending time working on this project.

My greatest thanks go to my highly dedicated supervisors; Lene Frost Andersen and Nanna Lien, for generously sharing of your experiences. Lene, thank you for your encouragement, involvement and support, including your fantastic laughter. Nanna, thank you for constructive feedback, and for introducing me to the world of behavioural sciences.

I would like to express a special thanks to Mona Bjelland, for your availability, dedication, and for immediately adding me as a member of the "HEIA family". To the other PhD students of the HEIA study; Mekdes K. Gebremariam, May Grydeland and Ingunn H. Bergh, thank you for the encouragement and involvement through my PhD work. A warm thanks to Jannicke Borch-Myhre, Anne Lene Kristiansen and Inger Therese L. Lillegaard, for invaluable feedback and support, as well as for enthusiastic relevant and irrelevant discussions along the way. Thanks to Nicolai A. Lund-Blix, for always and uncritically believing in me, and to Linda S. Sunde for being there every morning with a smile and a chat.

I have also received much support and joy from former and present colleagues in the group of Dietary Research at the Department of Nutrition, of which I am very grateful.

A particular thanks goes to Ingunn Narverud, for always being there as a supportive friend and colleague, and for all food and non-food related happenings throughout these years. To all of my enthusiastic friends, thanks for your interest, concern and thoughts. Especially all of those who have contributed with inspiring interruptions of breakfasts, lunches and dinners, as well as running and cross-country skiing experiences during these years, in the nice surroundings of Domus Medica. Finally, to all of my vagabond friends, this period have been fulfilled by exploring the world with you!

A warm appreciation to my caring family for being present and interested in every ups and downs of my work and life in general, as well as my parents in law for dedicated support along the way. Most of all thanks to my dearest Tollef Roe Steen for being positive, present and patient whenever needed, and for always encouraging me to continue with my work.

Oslo, 30.07.13

Torunn Holm Totland

TABLE OF CONTENT

LIST OF FIGURES AND TABLES

LIST OF PAPERS

Article 1

Torunn H Totland, Mekdes K Gebremariam, Nanna Lien, Mona Bjelland, May Grydeland, Ingunn H Bergh, Knut-Inge Klepp and Lene F Andersen (2012). Does tracking of dietary behaviours differ by parental education in children during the transition into adolescence? *Public Health Nutr.* **16**(4): 673-682

Article 2

Torunn H. Totland, Nanna Lien, Ingunn H. Bergh, Mona Bjelland, Mekdes K. Gebremariam, Knut-Inge Klepp and Lene F. Andersen (2013). The relationship between parental education and adolescents' soft drink intake from the age of 11–13 years, and possible mediating effects of availability and accessibility. *Br. J. Nutr.* Feb 4:1-8 [Epub ahead of print]

Article 3

Torunn H. Totland, Mona Bjelland, Nanna Lien, Ingunn H. Bergh, Mekdes K. Gebremariam, May Grydeland, Yngvar Ommundsen and Lene F. Andersen (2013). Adolescents' prospective screen time by gender and parental education, the mediation of parental influences. *Int J Behav Nutr Phys Act.* July 16;10(1):89 [Epub ahead of print]

ABBREVIATIONS

BMI	Body Mass Index
EBRB	Energy Balance Related Behaviours
HEIA	HEalth In Adolescents
HBSC	Health Behaviour in School aged Children
ICC	Intra Class Correlation
IOTF	International Obesity Task Force
PC/game	Computer and electronic game
SES	Socio-Economic Status
SSB	Sugar Sweetened Beverage
TV/DVD	Television and video
WHO	World Health Organization

1 INTRODUCTION

Several health behaviours that contribute to the epidemic of non-communicable diseases in adults are initiated during adolescence, such as tobacco use, alcohol use, and obesity inducing behaviours of unhealthy diet, physical activity and sedentary behaviours [1, 2]. Adolescence is defined by the World Health Organization (WHO) as the time period between 10 and 19 years [3], and the age of 10-11 years are considered to be a key transition age in a primary prevention perspective [4]. The adolescent's health is a result of interaction between influences in early childhood and the biological, social and behavioural changes during adolescence [1, 5]. Brain development and other biological changes that occur during puberty are known to influence the onset of health behaviours during adolescence, that may be crucial for future health [1]. The surrounding environment, such as families, schools and peers, are further found to strongly affect adolescents' health, and may thus facilitate good opportunities of a healthy lifestyle [6, 7]. As adult health is a result of exposure and processes throughout the life course [5], adolescence is considered a phase of life where foundations for a healthy future may be established [1, 5, 8].

1.1 The childhood obesity epidemic

The global obesity epidemic represents an enormous threat to public health, because overweight and obesity are major risk factors of non-communicable diseases like coronary heart disease and type 2 diabetes [9, 10]. Moreover, the second report on the prevention of cancer pointed out overweight and obesity as the major cause of several types of cancer [11]. Childhood overweight and obesity contribute to the obesity epidemic in adults as these children are more likely to become overweight or obese as adults [12-14], and thereby create a potential health challenge for the next generation worldwide [15].

Overweight and obesity are defined by the WHO [16] as abnormal or excessive fat accumulation that presents a risk to health. The crude measure of obesity is body mass index (BMI). An adult person with a BMI equal to or more than 25 kg/m^2 is classified as overweight, and a BMI equal to or more than 30 kg/m^2 is considered to be obesity [17]. Because BMI changes substantially with age during childhood, international based cut off points are needed to provide a tool for comparing prevalence rates across countries [18]. Age and gender specific BMI cut off values were thus proposed by the International Obesity Task

Force (IOTF), to internationally quantify childhood obesity [18]. The short term health consequences of overweight in children are not clear [16]. However, some effects of obesity are already observed in children, such as elevated low density lipoprotein cholesterol, high blood pressure, type 2 diabetes, asthma [11, 19, 20] and psychological related health outcomes [16, 20]. Long term health consequences of childhood overweight and obesity have further been observed in adulthood, such as metabolic disease, cardiovascular risk, morbidity and premature mortality [12, 20, 21].

1.1.1 Prevalence and trends

The prevalence of overweight and obesity has increased among children and adolescents worldwide [12, 15, 22], as well as in most European [22-24] and Nordic [25] countries during the past decades. A recent cross-sectional study among 10-12 year old children from seven European countries (the ENERGY study) found that 26% of boys and 22% of girls were overweight or obese, based on IOTF cut off points on objective measures [26]. Higher prevalence of overweight and obesity was observed in children from the southern and eastern parts of Europe compared to the northern parts [26, 27]. The prevalence of overweight and obesity among Norwegian boys and girls participating in the ENERGY study was 15% and 14% respectively [26]. This is comparable with what was observed in a national representative sample of 9 and 15 year olds, with IOTF cut offs on objective measured weight and height [28]. The figures from Norway are similar to what has been observed in other Nordic countries within this age group [27, 29, 30].

Cross-sectional trend data from a WHO collaborative survey among 43 countries across Europe and North America; the Health Behaviour in School aged Children (HBSC) study, reported an average increase of overweight and obesity from 14% among 11 year olds and 13% among 13 year olds in 2005-06 [31] to 15% and 14% in 2009-10 [32], respectively. The measures were based on IOTF based cut off points on self-reported data. National representative data among Norwegian 13 year olds showed an increase from 8% to 13% between 1993 and 2000, in cross-sectional trend data based on IOTF cut offs on self-reported data [33]. The Norwegian Child Growth Study observed an increase of overweight and obesity from 15% to 18% based on IOTF cut-offs on objective measures, among national samples of eight year olds (3rd graders) in the period from 2008 to 2010 [34]. However, the 2012 data of this study showed a prevalence of 16% overweight and obesity among Norwegian eight year olds [35]. This corresponds with the newest trend data in Sweden

showing a stable development of overweight and obesity among children and adolescents during the last years [30]. A recent review furthermore suggested that the prevalence of childhood obesity is levelling off both in the United States, Australia, Japan and in some European countries [36]. Although, this trend does not seem to have reached those with low socioeconomic status (SES) to the same degree as those with higher SES [36, 37]. A lack of objectively measured weight and height data on national representative samples have furthermore been reported in Europe [25, 37], and the stability of trend data needs further investigation [36-38].

1.1.2 Obesity prevention

The core problem of overweight and obesity is an imbalance between energy intake and expenditure over a prolonged period of time [12]. Although, the underlying factors are a complex constitution of societal and biological factors [12]. Genetic factors are well known to influence individuals' susceptibility to obesity [39, 40]. However, the increasing prevalence of obesity during the last decade is probably largely driven by environmental changes that encourage unhealthy lifestyles [40, 41]. Overweight and obesity among children are difficult to treat [42, 43], thus a public health effort to prevent unhealthy weight gain is needed [41, 44]. Public health efforts including recommendations of obesity prevention programs in Europe were discussed by the WHO already in 1997 [17], and several policy documents emphasizing the need for action have subsequently been published [9, 15, 45]. A Norwegian status report was presented in 2000 [46], followed by several national policy documents prioritizing children and adolescents across social groups in health promotion and disease prevention [47-50]. The importance of starting early in life in order to prevent obesity inducing behaviours of becoming habitual is highlighted [2, 13, 15, 50]. It is furthermore stated that parents are considered important in preventing children's weight related problems, and should be included in the prevention of obesity [7, 15, 50, 51].

The obesogenic environment provides less opportunities for healthy eating and activity behaviours [10], and is acknowledged to be an important promoter of the obesity epidemic [9, 52]. Regular physical activity and a high intake of dietary fibre are considered to be convincing protective factors against obesity, moreover supportive home and school environments are reported as probable protective factors for this matter [9, 10]. Convincing risk factors of obesity are sedentary lifestyles and a high intake of energy dense and micronutrient poor foods and a high intake of sugar sweetened beverages (SSB), while heavy

marketing of energy-dense foods is considered to be a probable risk factor of obesity [9, 10]. Beneficial effects on children's BMI are observed in obesity prevention programs that include a combination of lifestyle approaches [42, 53, 54]. Strategies to prevent obesity in children by encouraging healthy eating and activity behaviours are considered to be beneficial for all children and adolescents, despite weight status [43]. However, caution should be made that the strategies do not promote disordered eating and weight related harassment [43].

1.2 Energy balance related behaviours (EBRB)

Factors that raise energy intake or decrease energy expenditure by even a small amount may cause overweight or obesity in the long-term. Energy balance related behaviours (EBRB) refer to dietary, physical activity and sedentary behaviours that positively or negatively may influence weight status [55]. Thus, knowledge on EBRB is needed to understand the prevalence of obesity and other non-communicable diseases [26, 56, 57]. However, no single factor is responsible for obesity by it self, but rather the coexistence of EBRB that result in a positive energy balance within each individual [55]. Important dietary behaviours that are associated with increased overweight and obesity are a low intake of fibre, frequent energy dense snacking and frequent consumption of SSB, and important associations of activity behaviours are a low level of physical activity and more time spent sedentary [9, 55].

The concept of tracking is used in epidemiology literature to describe the longitudinal development of behaviours [58], and is generally used to indicate the risk of future diseases in subjects at an early age [59]. The study of tracking patterns is important when measuring stability and change in behaviour over time, and may help determine the proper timing for interventions to target a specific behaviour. Evidence of the tracking of EBRB between adolescence and into adulthood is reported [60-62], but relatively few studies have studied tracking between childhood and adolescence [61, 63]. Hence, there is a need for research to investigate longitudinal changes and tracking of EBRB in children during transition into adolescence [5, 63, 64].

This thesis focus on the EBRB related to dietary behaviours of young adolescents' consumption of fruits, vegetables, energy dense snacks and SSB, as well as behaviours of inactivity by adolescents' screen time, which will be further elaborated.

1.2.1 Dietary behaviours

Healthy dietary behaviours is particularly important among children and adolescents, given that these behaviours tend to be continued into adulthood [60]. Moreover, rapid changes in individuals' dietary behaviours may occur during adolescence [5, 65, 66]. Many children and adolescents fail to meet the dietary recommendations [67-69]. Thus, it is important to start at an early age in order to prevent unhealthy dietary behaviours of becoming habitual [56]. Investigating dietary behaviours in children during transition into adolescence longitudinally is therefore recommended in order to provide important information on when, how and why dietary changes occur [70-73], to be able to develop strategies for interventions [74, 75] and then further influence future health.

Fruits and vegetables

The intake of fruits and vegetables are considered to be part of a healthy balanced diet and has been associated with a lower risk of obesity [9, 76], especially based on their contribution to the intake of fibre [9, 77]. But more studies are needed in order to elucidate this relationship [78, 79]. A European study found the intake of fruits and vegetables to be lower than the recommended daily intake among both European and Norwegian 11 year olds [68]. The Norwegian national dietary survey among children and adolescents from the year of 2000 reported that 47% of boys and 48% of girls in 8th grade consumed less than 500 grams of fruit and vegetables a day [69]. On average the intake of fruits and vegetables were 255 grams/day among Norwegian 13 year olds in 2000 [69], and 216 grams/day in Norwegian 11 year olds in 2003 [68] in national representative samples. The intake of fruits and vegetables in different European countries are highly diverse, however figures from the Scandinavian countries are comparable [68]. Despite the low consumption, cross-sectional trend data from the HBSC study showed an increased frequency intake of fruits among Norwegian 11 year olds between 2001 and 2005 [80]. Results from another Norwegian cross-sectional trend study showed a decrease in frequency intake between 2001 and 2008 among 11-12 year olds, when both fruit and vegetable consumption were included [81].

Sugar sweetened beverages (SSB)

Soft drink consumption is found to be one of the EBRB associated with a positive energy balance among children and adolescents, and an important factor to consider in the prevention of obesity among children and adolescents [9-11, 82]. Furthermore, the consumption of soft

drinks is associated with an increased risk of tooth decay [83, 84]. The Norwegian national dietary survey among 13 year olds reported that on average 18% of the total energy intake were from added sugar [85], while the Norwegian nutrient recommendation is to limit the intake of added sugar to a maximum of 10% of the total energy intake [86]. The consumption of SSB among the 13 year olds contributed with 48% and 41% of the total intake of added sugar among boys and girls, respectively [69]. The consumption of soft drinks vary across Europe, reporting intakes from 92 ml/day among Greek girls to 700 ml/day among Dutch boys in a study of 10-12 year old adolescents from seven European countries in 2010 [26]. The consumption was 275 and 174 ml/day in Norwegian boys and girls [26], which is slightly less than the average of 336 and 242 ml/day reported among boys and girls in the Norwegian national dietary survey among 13 year olds in 2000 [69]. However, a decreasing cross-sectional trend in Norwegian adolescents' consumption frequency of soft drinks was observed among 11 and 12 year olds from 2001 to 2008 [87]. This is consistent with cross-sectional trend data from the HBSC study, showing a decrease in the consumption frequency of soft drinks among Norwegian 11 year olds from 2001 to 2005 [80].

Energy dense snacks

Energy dense and micronutrient poor snacking is also considered to be a risk factor of obesity [9, 10], and may furthermore displace children's intake of more healthful snacks such as fruit and vegetables [79]. In the Norwegian national dietary survey during the year of 2000, chocolate, cakes and sweets contributed with 24% and 32% of the total intake of added sugar in 13 year old boys and girls, respectively [69]. Moreover, the total intake of saturated fat was 13% in boys and 14% in girls measured as percentage of the total energy intake [69], which exceeds the Norwegian nutrient recommendation of a maximum of 10% of the total energy to be from saturated fats [86]. Chocolate, cakes, sweets and other snacks contributed with 24% and 29% of the total intake of saturated fat in boys and girls [69]. Data on adolescents' intake of snacks seem to be limited, but the number of snacking occasions have increased in both the United States and in European countries during the last decades [70, 88]. Recent Australian data does, however, report a slight decline in the intake of energy dense snacks among 12-13 year olds in 2004/2005 and followed up two years later [89]. A decrease in the consumption of sweets between 2001 and 2005 was also observed in all age groups of 11, 13, 15 and 16 years in the Norwegian data from the HBSC study [80].

1.2.2 Sedentary behaviours

Sedentary behaviours can be defined as low-energy expenditure activities [90-93], and reflect specific behaviours of very low intensity that indicate absence of activity [92, 94, 95]. It is important to notice that sedentary time and a failure to meet physical activity recommendations are considered as separate behaviours, and should be addressed independently [90, 93, 96]. The most common sedentary behaviours are related to desk-based work and education, motorized transport, sitting while socializing and screen time [90, 95]. Screen time includes time spent on watching television and videos, playing computer and electronic games and working on the computer, that is a major contributor to children and adolescents' time spent sedentary [97]. Television viewing is by far the most studied sedentary behaviour among children and adolescents [90-92], and other media based behaviours such as electronic games additionally needs to be addressed [94, 95]. Tracking of sedentary behaviours is observed from childhood and adolescence into adulthood [64], and time spent sedentary during childhood is further associated with several negative health consequences in adulthood [91, 98]. Hence, opportunities for good health and future patterns of adult health may be established in the transition phase of children growing into adolescence [1]. Priority should be given to gather new evidence from prospective studies of the sedentary behaviours of children and adolescents [60, 91, 95].

Screen time behaviours

Television viewing is associated with BMI and overweight among adolescents [91, 92, 99], as well as physical and psychosocial health [92]. However the evidence relating computer use and video games to obesity is less clear [99]. There are no stated recommendations to limit children or adolescents screen time in Norway. Although, several countries suggest a recommendation of spending a maximum of two hours/day on electronic media use [100-102]. The HBSC study reported in 2009-10 that 56% of 11 year olds watched television or video and DVD two hours or more on weekdays, which was a slightly larger proportion than the average reported by participating Norwegian 11 year olds [32]. Adolescents living in Europe are generally exceeding the media recommendations [103], however differences are found between countries [26, 104]. A recent review reported children and adolescents' average time spent watching television to be in the range of 1.5-3.7 hours/day among boys and in the range of 1.4-3.0 hours/day among girls [90].This is in correspondence with a previous review [93] as well as recent data from Europe including the Nordic countries [26,

104]. A recent European study further reported that the average frequency of time spent on television among Norwegian 10-12 years olds was 1.8 and 1.6 hours/day in boys and girls respectively, and average computer time was 1.5 hours/day among boys and 1.2 hours/day among girls [26]. Cross-sectional trend data among Norwegian adolescents show a decline in time spent on television viewing from 1993 through 2005 [80]. The figures are opposite for the use of computers and electronic games, showing an increase in usage between 2001 and 2005 [80].

1.3 Determinants of EBRB

Correlates and determinants refers to reproducible factors associated with behaviour, and are often used synonymously [105]. However, the term correlates are normally used cross-sectional, and do not support causal interferences [105]. Determinants may directly or indirectly influence behaviour, hence an indirect relationship may be affected through a third variable such as a confounder, covariate, moderator or mediator [106]. When the determinant influences a behaviour through an intermediate variable in the causal sequence, the variable is called a mediator [106]. Several determinants are related to EBRB, although the relationships differ from behaviour to behaviour and between target groups [55]. Thus, one single factor cannot be accountable for explaining behaviour, but rather a set of factors from multiple domains [107]. Determinants of EBRB may be non-modifiable such as sociodemographic characteristics or modifiable factors such as influences from the surrounding environment. A main challenge in obesity prevention lies in creating supportive environments for making healthy lifestyle choices [52]. It is therefore essential to determine factors in the environment that may influence the different EBRB, in order to support a healthy weight development [52, 55, 108]. Longitudinal studies are currently needed in order to identify possible environmental determinants of adolescents' EBRB [94, 109-111].

Theories and models can help to identify potential determinants of EBRB. Previous theories used to explain health related behaviours mainly focused on individual cognitive determinants of EBRB [112, 113]. As the environment of the modern society have changed in favour of unhealthy eating and activity behaviours [41, 95, 114], attention has been changed into acknowledging environmental determinants of health behaviours rather than the pure focus on individual determinants [10, 109]. Thus, current health related theories are mainly focused on the interrelation of individual and environmental factors to determine behaviour [109, 115].

This has led to a public health approach of ecological models in order to understand factors influencing obesity [52, 111]. In accordance to ecological models, multiple environmental levels might influence health [115]. An ecological model explains health behaviours through interaction between an individual and the surrounding interpersonal, institutional, community and public policy environments [116, 117] (Figure 1). More proximal interpersonal and institutional influences of where people meet and gather (e.g. homes, schools and neighbourhoods) can be referred to as the micro environment, and broader community and political infrastructures (e.g. town planning, transport and health system) are more distal environments that can be referred to as the macro level [52]. Individuals are thought to interact in a variety of micro environments that in turn are influenced by the larger macro environments [10]. Hence, these models can be used as an approach to disease prevention and health promotion by indentifying the influence of factors at different levels and the interactions between them [117, 118].

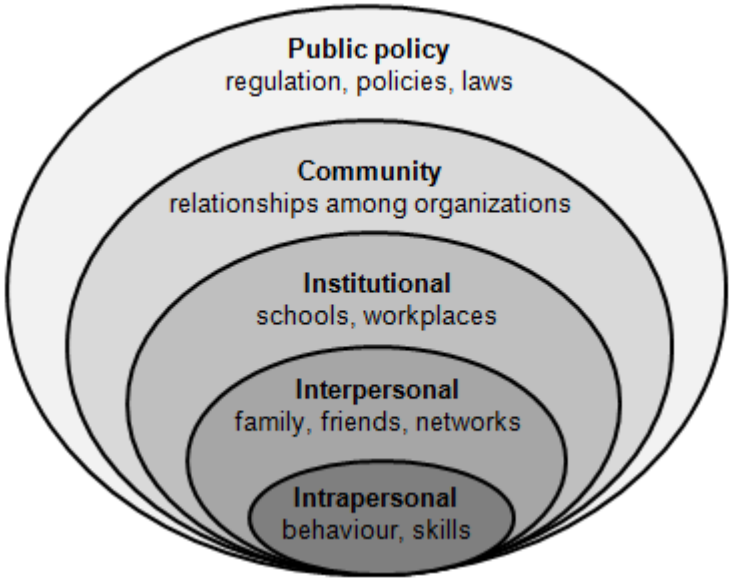

Figure 1 An ecological model, modified from McLeroy et. al. [116]

The Environmental Research framework for weight Gain prevention (EnRG) suggests that different environmental levels could influence EBRB both directly and indirectly through individual determinants [55] (Figure 2). This framework thus represent a dual-process view of how environment may influence behaviour [55], where each level of the environment is characterized by physical, sociocultural, economic and political domains as previously explained in a framework linked to dissecting obesity environments (ANGELO) [52]. The physical environment represents the availability of opportunities for healthy and unhealthy

choices, the sociocultural environment refers to social and cultural influences and norms, the economic environment represents cost related to healthy and unhealthy choices, and the political environment refers to the formal and informal rules related to healthy and unhealthy choices [52]. The direct influence indicates the automatic and unconscious effect of the environmental determinants on behaviour, and the indirect influence reflects the mediating role of individual cognitive factors in the effect of the environmental determinants on behaviour [55]. Various factors (e.g. gender) are furthermore suggested to moderate the relation either between environmental determinants and behaviour, or between the cognitive factors and behaviour [55].

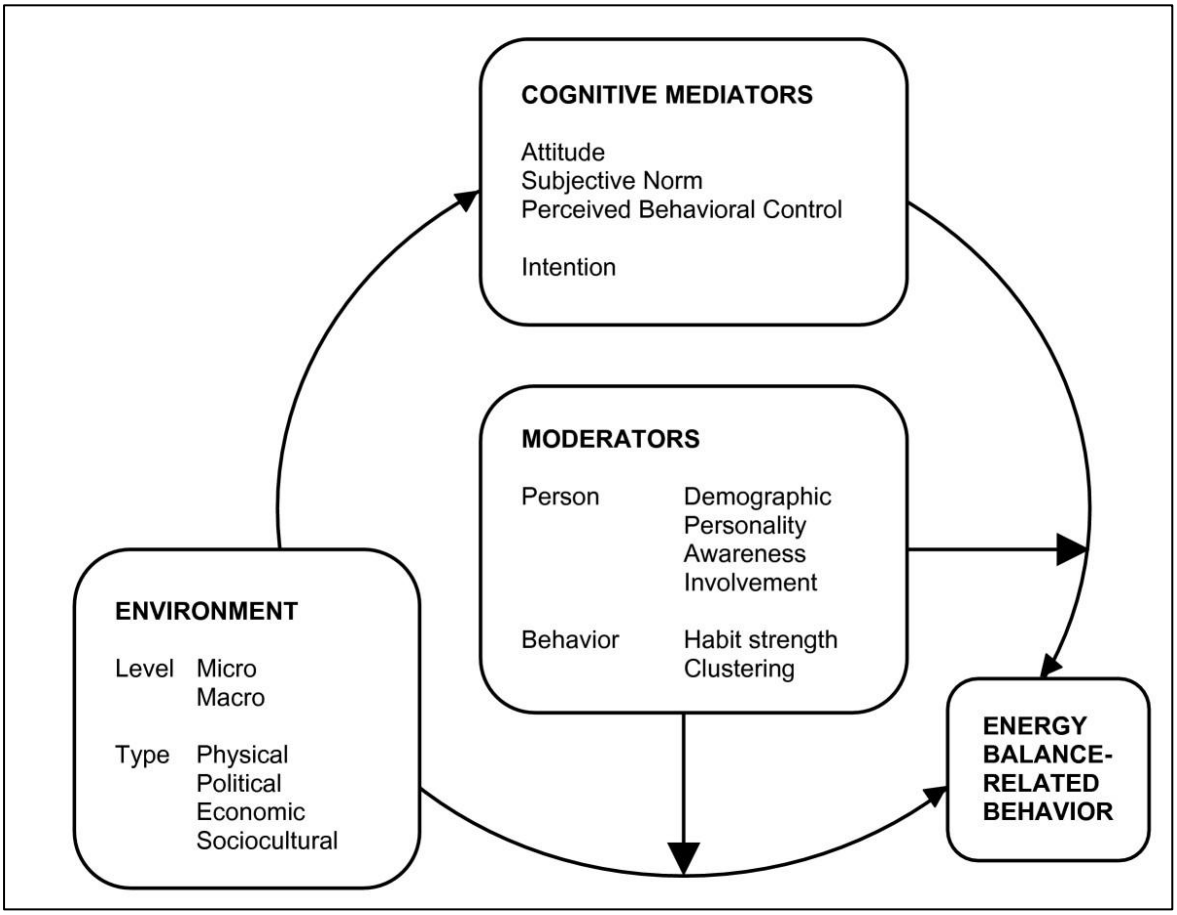

Figure 2 The Environmental Research framework for weight Gain prevention (EnRG) as proposed by Kremers et. al. [55][1].

For children and adolescents the micro environmental levels are believed to have the most influence on behaviour, such as family, school and peer influences [6, 10]. The home and family environment is the most important setting of children and adolescents' EBRB [10,

[1] This figure is distributed under the terms of the Creative Commons Attribution License.

119]. However, schools provide good opportunities to promote children and adolescents' health behaviours [10, 120]. Even though the importance of environmental influences on eating and activity behaviours have been recognized, specific areas such as consumption of energy rich foods and sedentary behaviours in the home are lacking empirical evidence [111]. Moreover, little research on EBRB is done with multivariate analyses, allowing for the adjustment of other potential individual or environmental correlates [109]. Thus, there is a need for studies to explore possible mediating and moderating pathways to improve the environmental research in obesity prevention [121].

1.3.1 Home environmental influences of behaviour

Parents play a crucial role in creating healthy home environments to influence the behaviours of their children [7, 10, 119, 122]. More research is needed to investigate parent's role in adolescents' EBRB [119, 123]. Longitudinal studies are needed to examine the relationship between the home environment and adolescents' dietary and sedentary behaviours [122, 124, 125]. Moreover, it is important to identify target determinants that may eliminate social inequalities in such behaviours [122].

Rosenkranz and Dzewaltowski's [119] model of the home food environment pertaining to childhood obesity proposes that the home food environment includes elements within all environmental domains. That is the political and economic level such as family SES, the physical (built and natural) level such as equipment, availability and accessibility, and sociocultural environments such as family traditions, practices and rules. All domains are suggested to influence children's dietary intake possibly through individual mediators and moderators of the child. Similarly, the conceptual model by Gattshall et. al. [123] focuses on the importance of the home environment through availability, accessibility, parental role modelling, and parental policies, in influencing children's healthy eating and physical activity.

Socioeconomic status

Socioeconomic conditions can be measured in several ways, such as by social class, socioeconomic position and SES. Socioeconomic position is a wider concept, commonly used in social epidemiology research [126], whereas SES is mainly based on the quantification of family income, parental occupational status, and parental education among children and

adolescents [127]. Income relates directly to the material conditions that may influence health, and occupation is the link between income and education that contributes to the structure of social roles [126]. Education reflects the knowledge of available resources that may influence health, and is shown to be associated with both occupation and income [128]. Level of education is considered to be the most important indicator of SES when investigating health related lifestyles in the Nordic countries [129].

SES has been investigated as a determinant of children and adolescents' dietary and sedentary behaviours, however inconsistent results were observed. A review investigating determinants of children and adolescents fruit and vegetable consumption reported that higher SES was associated with increased intake [130]. Whereas another review found positive associations between parental occupation and adolescents' fruit consumption [122], inconsistent results were reported between fruit and vegetable consumption and parental education by others [75, 110, 131]. A recent review further found household income and parental employment status inversely associated with adolescents soft drink consumption [122]. Inconsistent results were reported in regards to differences in soft drink and snacks intake by parental education [75, 110]. Reviewed evidence also revealed inconsistent associations between SES and sedentary behaviours [96, 122, 132]. The available evidence is mainly limited to cross-sectional findings [96]. Although, a negative association was found between parental education and television viewing among children and adolescents [96, 133], and between maternal education and computer use among young children [132].

Physical determinants

Parents are considered as important gatekeepers in controlling the home food environment by determining what, when and how foods are prepared in the home [10, 108]. Reviews of children and adolescents' fruit and vegetable consumption found availability and accessibility in the home to be important physical environmental correlates positively related to intake [110, 130, 134]. Although studies were limited with regards to adolescents [110], this was supported by a recent cross-sectional European study [135] and a recent prospective study [89] among adolescents. A recent review furthermore reported that availability of soft drinks at home was positively associated with adolescents' soft drink intake [122]. Availability and accessibility of soft drinks in the home, as well as drinking soft drinks with meals were suggested to be positively related to adolescents' soft drink intake in recent cross-sectional studies [136-138]. Another cross-sectional study found that access to unhealthy foods was

related to a higher intake of unhealthy foods in general [139]. A recent prospective study further reported home availability of energy dense foods to be positively associated with change in energy dense snack consumption among adolescents [89]. There is limited evidence on predictors of change in adolescents' dietary behaviours, and further studies are needed [89]. The availability of electronic forms of entertainment is one of the most profound changes in the developed societies in the world during the last decades [90]. Recent reviews report that physical environmental correlates of children and adolescents' screen time are related to availability of televisions [90, 132] and computers [90] in the home, as well as availability of television in the bedroom [90, 93, 132]. Prospective studies are needed in order to investigate these relationships longitudinally [125].

Sociocultural determinants

Reviews reported parental intake/modelling to be the most important sociocultural home environmental factor of children and adolescents' dietary intake [122, 130, 131]. A positive relationship of parental intake was reported for the intake of fruits and vegetables [130, 131], as well as an authoritative parenting style and family connectedness were positively associated with intake among adolescents [110]. A recent review furthermore reported that parental soft drink consumption and a permissive parenting style were positively associated with adolescents' soft drink intake, while parental limits and having family dinners were found to be inversely associated [122]. A cross-sectional study recently conducted in eight European countries furthermore suggested parental modelling, family consumption, parental permissiveness, monitoring and parental self-efficacy to be positively associated with an increase in adolescents' soft drink consumption [138]. There is little knowledge on correlates of children and adolescents' intake of energy dense snacks [110], and no consistent associations have been found.

A recent review concluded that parental rules/regulation were the most important correlate of adolescents' screen time, and that the relationship was inverse [122]. This was supported by other reviews [90, 132], which also found parental television viewing/modelling [90, 93, 133] and single-parent/guardian families [133] to be positively related to children and adolescents' screen time. However, recent evidence is reported as scarce [132], and more studies are needed to support these findings [90, 96]. Moreover, information is needed to identify correlates of different types of screen time behaviours as these may differ between television time and other screen time activities [93-95].

Parent-child gender dyads

Bandura [112] states that children's behaviours at home in general are more related to gender specific behaviours of parents with the same sex than the opposite, when growing older. However, gender related modelling is influenced by social contexts, such as gender conception of the behaviour, and may vary at different periods in life [112]. According to family system theories, each family member is shaping and being shaped by other family members' actions [140]. Parents in many Western societies today share time and responsibility for the daily care of their children more equally than in past generations [141]. Today fathers participate more in the daily care of children, and Scandinavian countries are quite modern societies in this respect. The child's gender identification with their same sex parent may therefore be influenced, and contribute to complex family relationships over time [141]. Associations of mother-daughter, mother-son, father-daughter and father-son are therefore interesting in an obesity prevention perspective [142].

Mothers' and father's parenting practices, support and modelling of dietary and sedentary behaviours are associated with adolescents' weight development [143]. Daughters with higher BMI were found among fathers who did not model or encourage healthy behaviours, and sons with higher BMI were found when both parents did not model healthy behaviours [143]. Differences between mothers' and fathers' parenting practices and modelling of healthy eating have furthermore been suggested to play a role in adolescents' weight development [143]. Also, overweight mothers have been shown to more often have sedentary daughters than normal weight mothers [144]. However, the role of parent-child relationships in adolescents' dietary and sedentary behaviours has been less studied.

Reviewed evidence on gender differences of children and adolescents' intake of fruits and vegetables generally found a higher intake among girls [130], which is supported by a recent prospective study [89]. An increased soft drink intake among adolescents were in cross-sectional studies associated with boys [136, 137, 145], which is also reported for the intake of energy dense snacks by both cross-sectional [145] and longitudinal [89] studies. Inconsistent results with regards to gender differences in adolescents' sedentary behaviours and screen time have been reported in reviews [90, 132, 133].

1.4 Aims

Due to the enormous public health consequences of overweight and obesity, and the documented gaps in international research literature regarding longitudinal studies of EBRB in children and adolescents, this study aimed to investigate the changes and tracking in children's dietary behaviours during the transition into adolescence. By studying the tracking of dietary behaviours, it will be possible to identify the critical age of which the onset of unhealthy dietary behaviours occur, which further may indicate when prevention efforts are of importance. Moreover, longitudinal studies are needed in order to identify possible determinants of adolescents' EBRB. As adolescents' EBRB are highly influenced by their home environment, this study aimed to investigate how the home environment influences young adolescents' obesity inducing dietary and screen time behaviours longitudinally. This study further aimed to examine the possible occurrence of multiple effects of home environmental determinants concurrently. By identifying potential modifiable mediators of adolescents' EBRB future interventions may be improved.

Based on the conceptual model of the HEalth In Adolescents (HEIA) study [146], a model was formed to visualize possible relationships between the home environment and adolescents' dietary and sedentary behaviours (Figure 3). The model was also inspired by previous conceptual models developed to investigate home environmental relationships [119, 123]. The proposed model further implies that the relationship between parental education and adolescents' dietary and sedentary behaviours may be mediated through other factors in the home food environment.

1.4.1 Research questions

The specific research questions proposed for the present thesis are listed as followed.

1) Do adolescents' dietary behaviours of fruits, vegetables, snacks, soft drinks and squash change between the ages of 11 and 13 years, and how does the intake track during adolescence? (Paper I)

2) What is the prospective relationship between parental education and adolescents' dietary and screen time behaviours? (Papers I, II & III)

3) Do home environmental determinants of availability, accessibility, parental modelling and/or regulation mediate the relationship between parental education and adolescents' prospective soft drink consumption or screen time at the age of 13 years? (Papers II & III)

4) Are there any gender relationships in dyads of parents' and adolescents' screen time? (Paper III)

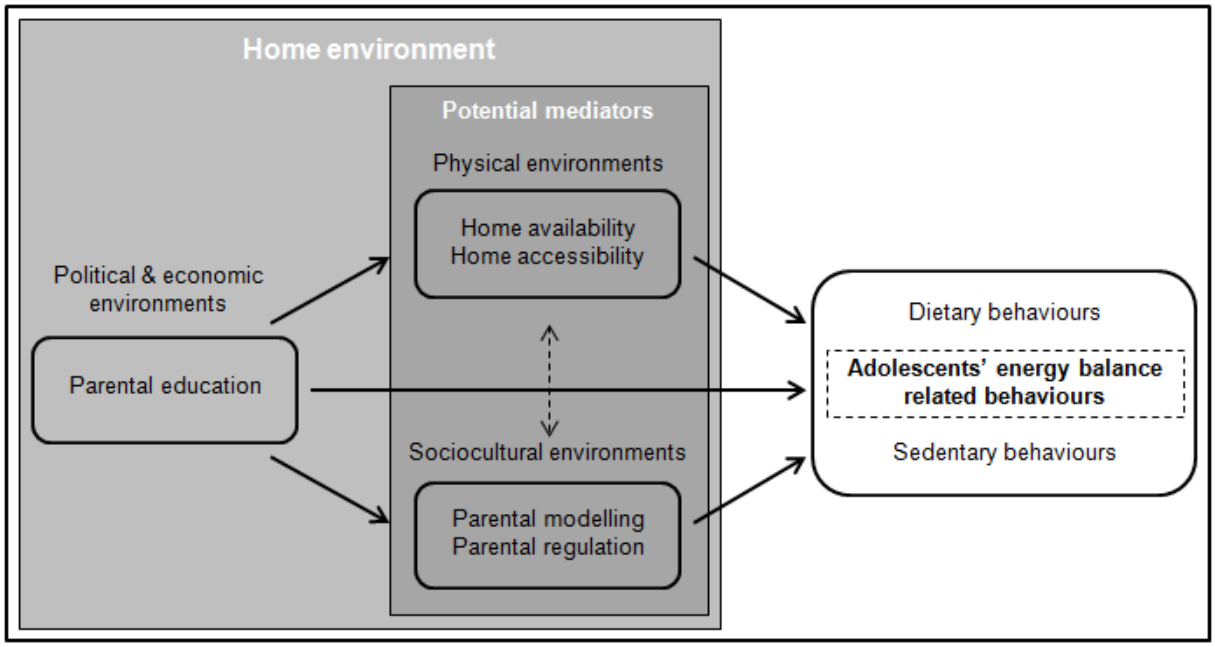

Figure 3 Model of the influence of the home food environment on adolescents' energy balance related behaviours.

2 METHOD

The HEIA study was a 20 month school-based intervention study carried out among pupils in 6th through 7th grade in 2007 to 2009, as a collaboration between the University of Oslo and Norwegian School of Sport Sciences. The overall aim was to promote healthy weight development in school children through dietary behaviours and physical activity. Seven counties in the south-eastern part of Norway were targeted, and 177 schools with a minimum of 40 enrolled pupils in 6th grade were identified and invited to participate. A total of 37 schools agreed to take part in the HEIA study, and these were randomly assigned into 12 intervention schools and 25 control schools with a cluster-randomized controlled design. Approval for the study was obtained from the Regional Committees for Medical Research Ethics and the Norwegian Social Science Data Service. Participation in the study was voluntary at all times. The papers suggested for this thesis is based on the HEIA cohort study, which include data collected from all participants in the 25 control schools of the HEIA study. The design and methodology of the intervention study is described in detail elsewhere [146].

2.1 Subjects and study design

All 6th graders and their parents/legal guardians (hereafter referred to as parents) from the 25 control schools were invited to participate, resulting in 1381 eligible adolescents for the HEIA cohort (Figure 4). Parent signed informed consent forms were obtained from 1014 (73%) of the adolescents, and data was collected at three time points. The baseline survey (T0) was carried out in September 2007 with 975 (71 %) participating adolescents. In May 2008 the first follow-up (T1) was conducted including the attendance of 970 (70 %) adolescents, and 20 months after T0 a second follow-up (T2) was conducted during May 2009. There were 945 (68 %) adolescents participating at T2, and altogether 885 (64%) of the adolescents attended all there time points of data collection. Parental participation among included adolescents was 738 (76%) mothers and 630 (65%) fathers at T0.

At all time points adolescents answered Internet-based questionnaires assessing dietary, physical activity and sedentary behaviours and their determinants. The questionnaires consisted of mostly pre-coded answer categories, and were distributed during school hours. Adolescents' spent about one school hour (45 minutes) in order to complete the questionnaire, and project workers were available during data collection sessions. The dietary behaviours

investigated were intake of fruits, vegetables, snacks and beverages. Physical activity was investigated by school- and leisure time activity and active transport, and sedentary behaviours by television and video viewing (TV/DVD), and computer and electronic game use (PC/game). Anthropometrics were measured among adolescents by project workers at T0 and T2, and separate forms were filled in assessing puberty status. Moreover, physical activity was objectively measured by accelerometers in five consecutive days, including two weekend days.

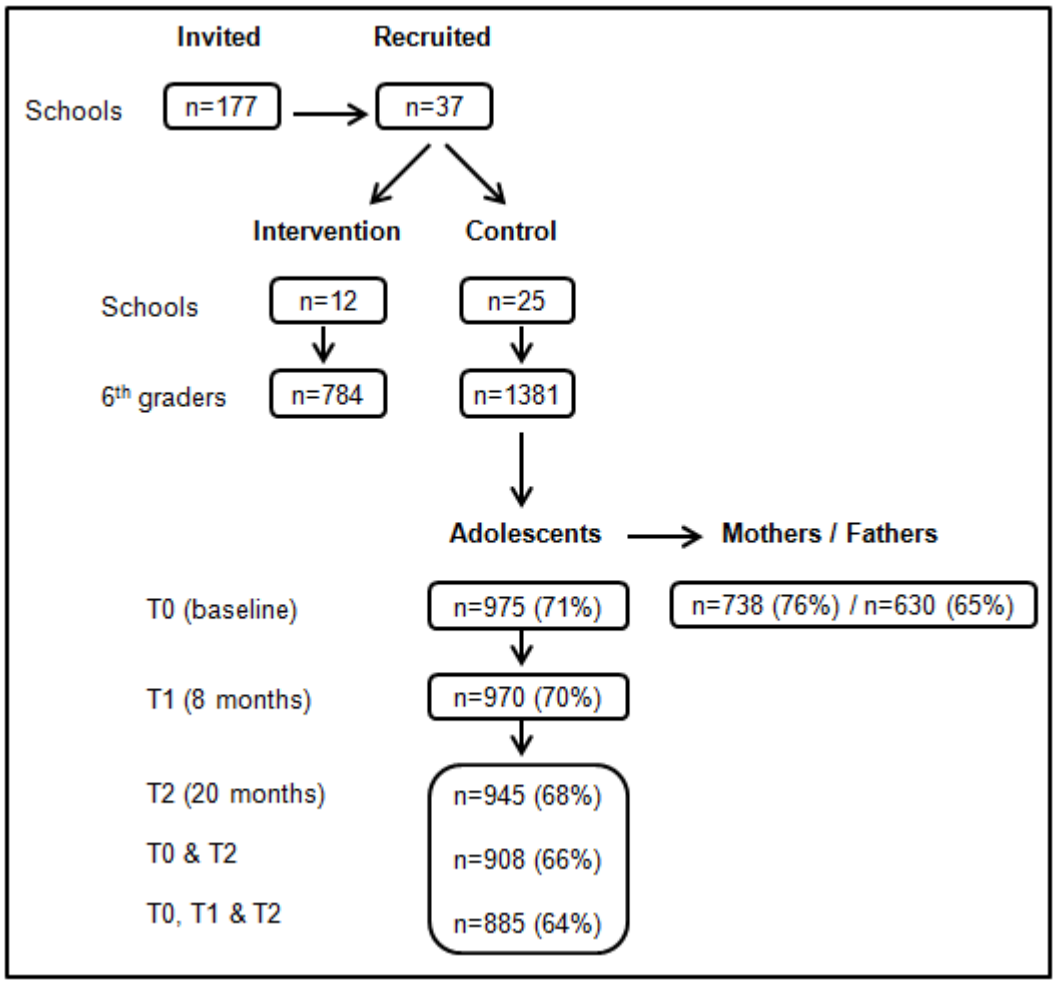

Figure 4 The HEIA cohort study, flowchart of participation

Adolescents brought home scan-able questionnaires for both their parents to fill in at T0 and T2. These were to be sealed in envelopes, returned to schools and then picked up by project workers. Mothers and fathers were asked to answer similar pre-coded questions as their adolescents assessing dietary, physical activity and sedentary behaviours, their determinants, as well as determinants related to their child's behaviours. Parents self-reported height, weight, hip and waist circumferences were collected through their questionnaires. A separate

home food inventory questionnaire was answered by mothers at T0 and by either mothers or fathers at T2, assessing the availability of foods and drinks in the home at a specific time point.

A separate test-retest study was conducted among 114 6th graders from four schools sampled in the same area as the main study. The mothers' (n=43), fathers' (n=35) and children's questionnaires and anthropometric measurements of the child were measured with two weeks apart [146]. Spearman's rank correlation coefficient was used to assess the two week test-retest reliability of measurements presented in the papers (Table 1). The HEIA questionnaires were not validated by themselves. However, most of the questions were adopted from previously validated instruments (Appendix 1 and 2), as described in the following section.

2.2 Assessment of variables

All variables included in this thesis were assessed by the questionnaires measuring adolescents at T0, T1 and T2, and both parents at T0. The questions included in the current analyses are summarized in Appendix 1 and 2.

2.2.1 Demographics

Parental education for both caregivers was assessed through the adolescents' consent forms by the question "What is your highest level of education?" The answer categories were based on levels proposed by statistics Norway: less than 7 years, elementary school (7-9 years), high school/comprehensive school (10-12 years), lower college/university (1-4 years) or higher college/university (>4 years). For the purpose of the present analyses, level of parental education was either divided into three categories of low (≤12 years), medium (lower college/university) and high (higher college/university) education, or dichotomously into low (≤12 years) and high (college/university attendance) education. Living status of the adolescents were measured by the question "Which adults are you living with at the moment?" with the answer categories: living with my mother and father, my mother only, my father only, fifty/fifty with my mother or my father, my mother and her partner, my father and his partner, with foster parents or with other adults, please specify. In the present analyses, living status was dichotomously divided into living in two-parent families (including parents and step-parents) and living in other families.

2.2.2 Anthropometrics

Adolescents' height was measured by same-sex project workers to the nearest 0.1 cm on a wall-mounted measuring tape with the adolescents standing up against the wall and without shoes. Weight was measured on light clothed adolescents to the nearest 0.1 kg by a Tanita scale. More details of the anthropometric measurements are described elsewhere [147]. BMI was calculated as weight/(height*height), and age- and gender specific cut-off values developed by the IOTF were used to categorize the adolescents into non-overweight or overweight/obese [18].

2.2.3 Behaviours

The intake of foods were measured by frequency for the following items; fresh fruits, raw and cooked vegetables, chocolates and sweets, salty snacks, sweet biscuits, cakes and buns [146]. Consumption of beverages were measured by frequency and amount for the following items; sugar sweetened and diet soft drinks and squash, ice tea, fruit juices, fruit drinks, flavoured milk products and water [146]. The questions used were based on already existing questionnaires [69, 148], and modified to suit to the HEIA study. The original questionnaires were previously validated among Norwegian adolescents, and satisfactory correlations between the questionnaires and the reference methods were obtained in these validation studies [149, 150]. The food items included in the present study were intake of fresh fruits (further referred to as fruits), raw and cooked vegetables (further referred to as vegetables), chocolates, sweets and salty snacks (further referred to as snacks), carbonated sugar sweetened soft drinks (further referred to as soft drinks) and sugar sweetened squash (further referred to as squash). The food items of sweet biscuits, cakes and buns, ice tea and flavoured milk products were excluded in the current analyses, since they were only measured among adolescents at T0 and T2. Other beverages than soft drinks and squash were not included in this thesis, as these were the most interesting beverages in an EBRB perspective. Moreover, determinants were not measured for other beverages than soft drinks and squash. Test-retest correlation coefficients from the HEIA reliability study showed acceptable consistency over two weeks, ranging from 0.5 to 0.8, for adolescents intake of the included dietary items (Table 1).

Table 1 Test-retest correlation coefficients of included behaviours and determinants

		Adolescents		Mothers		Fathers	
Variables	**Values**	**n**	**Sr**	**n**	**Sr**	**n**	**Sr**
Behaviours							
Fruits	frequency/week	111	0.78				
Vegetables	frequency/week	106	0.77				
Snacks	frequency/week	106	0.50				
Soft drinks	dl/week	95	0.73				
Squash	dl/week	84	0.73				
TV/DVD	hours/week	107	0.72	44	0.83	35	0.91
PC/games	hours/week	105	0.71	44	0.51	34	0.81
Determinants							
Availability soft drinks	yes/no			41	0.61		
Accessibility soft drinks	6 point scale	111	0.67	43	0.71	34	0.65
Regulation TV/DVD	5 point scale			44	0.32	35	0.39
Regulation PC/games	5 point scale			44	0.69	35	0.52

Sr: Spearman's rank correlation coefficient

Sedentary behaviours were measured as frequency and amount of time spent on TV/DVD and PC/games. The question on TV/DVD time was modified from the PEACH study that included 10-11 year old British children [151]. For the purpose of the present study, time used during weekday and weekend days were distinguished during assessment, as suggested by the HBSC study [152]. Time spent on PC/games was not included in the PEACH study, and subsequently the authors composed a similar question to assess the usual time spent on PC/games during spare time. Acceptable correlations of 0.7 among adolescents and 0.5 to 0.9 among parents, were found in the HEIA reliability study when measuring screen time behaviours (Table 1).

2.2.4 Determinants

Perceived accessibility of soft drinks at home was measured among adolescents, mothers and fathers. The questions were modified from the Norwegian Fruit and Vegetables Make the Marks study, that was conducted among Norwegian 6th and 7th graders and their parents [136, 153]. Availability of soft drinks in the home was measured among mothers through the home food inventory questionnaire. The questionnaire was previously validated in an American study including families of 10-17 year old students, obtaining satisfactory validity among the parents of which 76% were mothers [154]. Test-retest reliability scores from the HEIA study

showed acceptable correlations of 0.7 among adolescents and 0.6-0.7 among parents, for measurements of perceived accessibility and availability in the home (Table 1).

Parental regulation of adolescents' time spent on TV/DVD and PC/games was measured among mothers and fathers. The question on regulation of TV/DVD time was derived from a previously reliability tested and published instrument [155], whereas the question on regulation of PC/games was composed based on this question. The original construct measured parental regulation of TV/DVD based on a six items scale. However, in order to keep as many parents as possible in the analyses of the present thesis, only the question directly related to parental regulation of television viewing was included. The answer categories were measured on a five point Likert scale. A variety of correlation coefficients, ranging from 0.3 to 0.7, were obtained in mothers' and fathers' test-retest measurements of parental regulation (Table 1). The weakest correlations were found in both parents regulation of TV/DVD, whereas acceptable correlations were found in parents' regulation of PC/games.

2.3 Statistical analyses

Demographics were presented by means and 95% confidence intervals (CI) unless otherwise stated. The significance level was set to $p<0.05$, and all statistical analyses were performed by IBM® SPSS® Statistics, version 18.0 (IBM Corp., Somers, New York, USA). Differences in continuous variables were investigated by t-test or analysis of variance (ANOVA), and chi-squared test was used for categorical data. Pearson's correlation coefficient was performed to investigate parametric associations of continuous variables, and Spearman's rank correlation coefficient was used for non-parametric associations. Both parametric and non-parametric tests were tested when the distribution of data were questionable, and presented with parametric tests when the results were similar and number of cases were high. Bonferroni correction was used when adjusting for multiple testing.

2.3.1 Clustering effect by school

The cluster effect of the behavioural variables was tested by using Linear Mixed Models, as the participants were invited through schools. Individuals within a defined group are thought to be more similar than those of other groups. The intraclass correlation (ICC) was used to quantify the degree of clustering of individuals at the school level. However, if the ICC is

small there is no meaningful difference among groups, and the data may be analyzed at the individual level with disregards to the clustering effect [156, 157]. Moreover, the HEIA study found adolescents' dietary behaviours to be independent of school-level [158], as supported by a recent review stating that intrapersonal factors play a more important role [75]. Little is known about the influence of school on adolescents' sedentary behaviours [122]. However, the HEIA study reported a low unexplained variance of the included screen-time behaviours at the school level [159], and therefore multilevel analyses were not performed.

2.3.2 Tracking

Tracking can be defined as the relative stability of behaviour over time [58], or to maintain the relative position in rank within a group over time [160]. The present study used several methods in order to describe the magnitude of tracking in adolescents' intake of fruits, vegetables, snacks, soft drinks and squash over 20 months. First, tracking of variables was illustrated by tracking patterns at T0, T1 and T2 based on groups of consumption at T0. Second, stability was shown by the percentage of individuals remaining in the same group of consumption at T0 and T2, and change was presented by percentages of decrease or increase in consumption between the time points. Third, Cohen's weighted kappa was used as tracking coefficients to test the agreement between each individual's relative position in rank from T0 to T2. The Kappa values were weighted in order to take into account the distance of movement between groups, based on the squared distance between categories as suggested by Fleiss and Cohen [161]. The available command syntax for SPSS (IBM Corp., SPSS Statistics 2010, Somers, New York, USA) was used, in order to calculate Cohen's weighted kappa. Finally, multinomial logistic regression was used to investigate possible associations between level of parental education and the tracking of each of the dietary variables from T0 to T2.

2.3.3 Mediation

Mediators are defined as modifiable determinants that transmit the effect of an independent variable (X) on a dependent variable (Y) [106, 162]. A conceptual model of single mediation is shown in Figure 5, based on the model proposed by MacKinnon, Fairchild and Fritz [106]. The total effect of X on Y is represented by the c-path. The a-path represents the relationship between X and the mediator (M), and the b-path represents the relationship between M and Y when adjusted for X. The direct effect of X on Y, when adjusted for M is represented by the

c'-path [106]. The mediation effect is calculated either by the a-path multiplied by the b-path (a*b) or by subtracting the c'-path from the c-path (c-c') [106, 163]. The single mediation model may be extended to include multiple independent variables, mediators or outcomes allowing for multilevel analyses, subgroup analyses and analyses of longitudinal data [106].

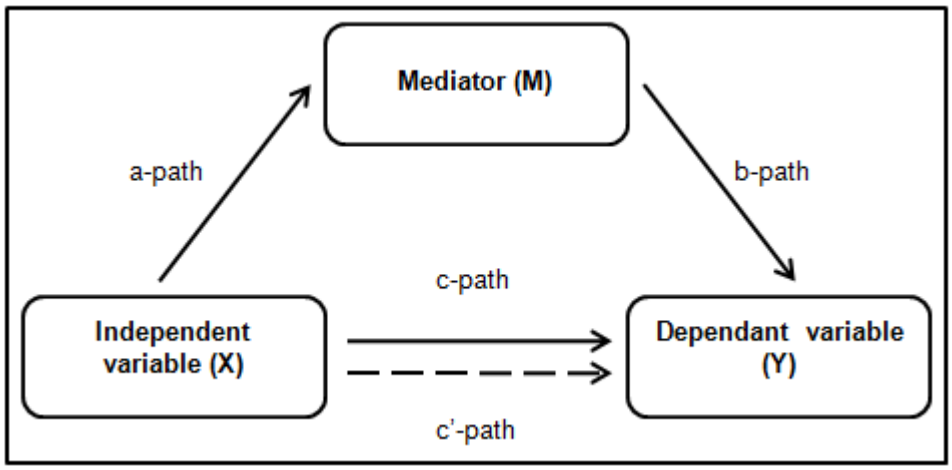

Figure 5 Mediation analysis

There are several assumptions related to single mediation analysis [106]. However, to statistically test all assumptions of mediation is not feasible, and so proof of mediation may be counted as impossible without taking proper evidence from previous research into account [106]. Statistical assumptions for mediation analyses were examined by testing normality of residuals, with Probability plots and Scatter plots. Moreover, outliers were checked for by Mahalanobis and Cook's distance tests. Durbin-Watson statistics and Dot plots were computed in order to check for independence between the residuals. Coefficients of collinearity were used to look for correlation between the independent variables, and possible interactions of X*M were investigated.

The statistical assumptions for the mediation analyses included in the present thesis were considered acceptable. The distribution of residuals was satisfactory and no extreme outliers were detected. Furthermore, independence of the a-path and b-path residuals were confirmed, and no interaction between X and M were detected. Finally, the causal order of the model was assumed to not exceed the proposed directions. Mediation was then investigated by linear regression using the available SPSS script proposed by Preacher & Hayes [163]. Confidence intervals and level of significance were obtained by bias-corrected bootstrapping of 1000 independent samples [163], which is recommended as the most powerful method to obtain power estimates of 0.8 in mediation analyses with smaller samples [164].

3 RESULTS

3.1 Paper I – Tracking of dietary behaviours in adolescents

This paper investigated the tracking and change in intake of fruits, vegetables, snacks, soft drinks and squash between the ages of 11 and 13 years, and possible differences by parental education. A total of 885 adolescents attended all time points of data collection, with 53% participating boys. The mean age was 11 years at T0, 12 years at T1 and 13 years at T2 in both genders. No significant changes were seen in the adolescents' intake of any of the dietary behaviours investigated between T0 and T1. However, the intake of soft drinks increased significantly over time by 0.9 and 0.7 dl/week in boys and girls, respectively, from T0 to T2.

The results further indicated that boys and girls generally maintained their relative position in rank for their intake of fruits, vegetables, snacks, soft drinks and squash between the ages of 11 to 13 years, when grouped by baseline consumption. The highest proportion of stability was observed for the intake of squash in both genders. Tracking coefficients indicated fair tracking of fruits, vegetables, snacks and soft drinks among boys, and of vegetables and snacks among girls from T0 to T2. Moderate tracking coefficients were observed for boys' intake of squash and girls intake of fruits, soft drinks and squash.

An inverse association was found in both genders between level of parental education and tracking in adolescents' soft drink and squash consumption during the 20 months of assessment. Boys and girls with parents of high education had higher odds of a stable low intake of soft drinks and squash, when compared to those with parents of low education (OR=2.6-3.9). No significant associations were seen between level of parental education and tracking of fruits, vegetables or snacks between the ages of 11 to 13 years.

3.2 Paper II – Adolescents' prospective intake of soft drinks

The prospective relationship between parental education and adolescents' soft drink intake from the age of 11 to 13 years was investigated in this paper by the prediction and change in the behaviour over 20 months. Moreover, possible mediating effects of availability and perceived accessibility of soft drinks at home were examined. Data were obtained from the 908 adolescents attending T0 and T2, and 866 of these were meeting the analytical criteria of having valid data on parental education at T0 and soft drink consumption at T2. Additionally, mothers (n=738) and fathers (n=630) with parental reports at T0 were included in the analyses. A total of 31% of the adolescents had parents with lower education, compared to having parents that attended university/collage. Adolescents with parents of low education consumed significantly more soft drinks at both time points, than those of parents with high education. Moreover, a significant relationship were observed between a lower level of parental education and a higher perceived accessibility of soft drinks as measured by adolescents, by mothers and by fathers at T0. No difference by parental education was seen for the availability of soft drinks at home.

Mediation analyses consistently found a lower level of parental education to predict a higher intake of soft drinks among adolescents at the age of 13 years (c-path). Perceived accessibility of soft drinks reported by adolescents and mothers partly mediated this relationship by explaining 39% of the total effect. Furthermore, perceived accessibility reported by adolescents, mothers and fathers and availability at home were significant predictors of adolescents' soft drink intake between the ages of 11 and 13 years (b-path). No relationship was observed between parental education and the change in adolescents' intake of soft drinks during the 20 months, and no mediation effects of perceived accessibility reported by adolescents, mothers or fathers or availability at home were observed.

3.3 Paper III – Parental influence on adolescents' prospective screen time

The purpose of this paper was to investigate the influence of parental modelling and regulation on adolescents' prospective TV/DVD and PC/game time between the ages of 11 to 13 years, in parent-child gender relationships and as mediators of differences by parental education. The 908 adolescents attending T0 and T2 were included in the present analyses, as well as their participating mothers (n=738) and fathers (n=630) at T0. Adolescents and parents reported similar time spent on TV/DVD at T0, but time spent on PC/games differed between adolescents' and parents' reports. Significant associations were furthermore observed in gender dyads of parents and adolescents time spent on TV/DVD at the age of 11 and 13 years. Associations between mothers and sons and between fathers and daughters were also observed in time spent on PC/games at the age of 11 years.

Mediation analyses showed a lower level of parental education to predict more time spent on PC/games among adolescents at the age of 13 years (c-path), but no such relationship was observed for adolescents' prospective TV/DVD time. Maternal and paternal modelling was, however, found to mediate the prospective relationship of parental education predicting adolescents' TV/DVD time at the age of 13 years. Both maternal and paternal modelling were furthermore positively associated with adolescents' time spent on TV/DVD between the ages of 11 and 13 years, while maternal and paternal regulation were inversely related (b-path). No mediating effects were observed for maternal or paternal modelling or regulation of adolescents' prospective PC/game time. Although, paternal modelling were found to be positively associated with adolescents' time spent on PC/games between the ages of 11 to 13 years (b-path).

4 DISCUSSION

Ecological models emphasize the importance of environmental factors in adolescents' health behaviours. Thus, behaviours that influence children's weight status occur within a context that is both complex and highly interactive. Children's weight status is thought to be influenced by environmental factors both proximal and distal to the child [119]. However, the home environment is considered as most important in preventing children's weight related problems [119].

This thesis highlights the importance of the home environment for young adolescents' dietary and screen time behaviours. Methodological aspects influencing the results will be considered, followed by a discussion of the results.

4.1 Methodological considerations

There are several strengths of the present study, first the longitudinal study design based on a relatively large sample size at a narrow age range. Second, the rate of subject retention was very high. Third, the multiple EBRB investigated rendered the possibility of looking at different aspects of the adolescents' lifestyles. Forth, the included questions assessing dietary and screen time behaviours among adolescents obtained acceptable test-retest correlations, indicating reliability of the measures. Fifth, parental reports of parental characteristics are considered to give more reliable measurements than when collected from the adolescents themselves. Sixth, the study included both parents, giving the opportunity of studying mothers' and fathers' reports separately. Finally, multiple methods were used in order to investigate longitudinal relationships of adolescents' dietary and screen time behaviours.

4.1.1 Generalizability

The schools invited to participate in the HEIA study were situated in the largest towns/municipalities in the eastern part of Norway. Thus the results cannot be generalized as national representative. A weakness of the study further includes a low response rate of schools initially invited to participate, with a potential selection bias. While the participation rate of sampled schools was only 21 %, attrition analyses showed that there was no significant difference in terms of the number of students in the sixth grade and overall size between

schools that participated in the study and schools that declined participation [158]. Moreover, schools were included from all seven counties targeted in the HEIA study. Due to ethical considerations, reason for non-participation was not enquired. However, some schools (n=50) provided a reason for non-participation, with the most common reason being participation in other similar studies [158]. In addition, weighing of children is continuously debated in the Norwegian media, and may have affected the willingness of participation among schools. The prevalence of BMI within the total HEIA sample of 1485 participating adolescents was comparable with national data [28], thus indicating representativeness among this age group.

Data on SES characteristics are unfortunately not nationally registered at the school level in Norway, and thus SES of the 37 participating schools compared with the 177 invited schools are not available [165]. However, data on parental education was collected among 1527 adolescents in the total HEIA sample, corresponding with 71% of those invited to participate. When comparing the parental educational level of the total HEIA sample with the national educational level reported among 30-49 year olds by Statistics Norway, the proportion of the lowest educated parents (≤12 years) was about halved among the HEIA parents [165]. This means that the representativeness of the parents based on their education level can be questioned. Although a contributing factor might be that level of parental education is somewhat higher among those living in the eastern region of Norway [165], because there is a higher concentration of education institutions in this area. Overall, the generalizability of our findings is limited to represent highly educated people from the semi-urban areas surrounding the south-eastern region of Norway.

Attrition occurs due to drop-out in follow-up data collections, and poses threats to the generalizability of the result. The proportion of participating adolescents' lost to follow up was small in the present study, and thus not a big concern for the results. However, missing values appeared as a potential problem when including parental reports in the analyses. Attrition analyses was therefore conducted in each paper, comparing baseline data from the included participants with participants lost due to missing in parental reports. The differences between these samples were generally small, and did not seem to pose severe threats to the validity of the conclusions of this thesis. However, a higher level of parental education, living in two-parent families, a normal weight status and less time spent on PC/game were observed among adolescents in the subsample included in paper III when compared to the baseline sample of 975 adolescents. Analyses were thus adjusted for living status and weight status,

however differences by parental education may have been underestimated. The subsample analyses including parental reports may generally be skewed towards a more health conscious population, as the included parents might represent more interested and persistent than the parents that did not participate.

4.1.2 Reliability and validity of research instruments

Data collection of adolescents' dietary and screen-time behaviours was based on self-reported measures of frequency questionnaires, which may raise possible challenges due to measurement error. Children older than eight years have generally a higher ability to self-report than younger children, and cognitive abilities of reports are expected to be fully developed among adolescents [166]. However, issues of motivation and body-image may influence willingness to report on dietary intakes during adolescence [166], as well as issues of social expectations and norms in relation to the reporting of screen time behaviours [167]. A recent review concluded that the reliability and validity of self-reported food frequency questionnaires are generally acceptable among children and adolescents [168]. Self-reported measurements of screen time behaviours were in a recent review also found to provide reliable estimates among children and adolescents, although validity is largely untested [169]. Thus, caution should be made when interpreting the results of such instruments, and multiple studies are needed to be able to conclude. Finally, the questionnaire assessing adolescents' behaviours was in the present study Internet-based. However, mode of administration of questionnaires, computer or paper, have not been found to have significant effect on responses from adolescents on the majority of lifestyle behaviours [170].

As previously shown (Table 1), acceptable test-retest correlations of adolescents' reports were observed among adolescents participating in the present study, indicating reliability of the results. Although, this does not account for the possibility of information bias among the adolescents' reports if this was done consistently at both time points. The questions measuring adolescents' behaviours were mostly based on previously validated questionnaires within this age group. The intakes of fruits, vegetables, soft drinks and squash was furthermore compared between the 13 year olds in the HEIA cohort study (T2) with nationally representative data among 13 year olds in the year of 2000. Frequency of intakes of fruits and vegetables in the present study was thus calculated into grams/times/day as suggested by the corresponding validation study [149]. Although, the intake of fruits was higher and the intake of soft drinks and squash was lower in the HEIA cohort study than what was reported in the year of 2000,

recent trend studies consistently suggest such changes in frequency of intakes since the year of 2001 [80, 87]. Time spent on TV/DVD and PC/games among 11 year olds in the HEIA cohort study (T0) is comparable with nationally representative data among 9 year olds in 2011. Thus we believe a relative accuracy of the measurements used assessing dietary and screen time behaviours in the present thesis.

The use of parental education as an indicator of the adolescents' family SES has both advantages and drawbacks. Parental education is a hierarchic indicator of a persons SES, and the advantages include that education is easy to report and that few members of the population are excluded [126, 128, 171]. Moreover, level of education among adults undergoes small changes over the years, is considered available in both genders, and self reported measurements are considered to be reliable [126, 171]. Drawbacks are related to comparison with other countries, as well as across a larger time span and generations [126, 171]. However, such drawbacks are not considered as an issue in the HEIA study. The parental education variable used in the present analyses included information from the parent with the highest educational level, or else the one available. This was chosen in order to account for the highest educational level within the family, as mothers and fathers in the Western societies today are believed to share time and responsibility for the daily care of their children [141]. By using this variable, the parental educational level of the included adolescents may appear artificially high. However, as data is longitudinally measured among the same individuals, the level of parental education will still represent these adolescents' behaviours prospectively.

Measurements of home availability and accessibility are diverse, which are confusing and make comparisons between studies difficult [154, 172]. The availability of foods have previously been defined as whether foods are present in an environment, and accessibility as whether these foods are available in any form [172, 173]. Several validated measures of the availability of fruits and vegetables have been proposed [172, 174], and good validity and reliability are generally reported among adults for the self-report of food availability in the home through home food inventories [123, 154, 174]. However, few instruments provide comprehensive assessments of food availability in the home [154, 174], and few validated measures were found for the availability and accessibility of unhealthy foods such as SSB in the home [123]. Presumed accessibility of soft drinks was in the present study measured by adolescents and parent with the question: "When soft drinks with sugar are available at home,

can you (your child) serve yourself (him-/herself) as you (he/she) please(s)?". Hence, when asked among parents the question did not only measure presumed accessibility of soft drinks in the home, but to some extent also imply rules of consumption. However, no studies were identified to investigate parental regulation of adolescents' soft drink consumption by parental reports, and thereby data on validation testing of such measurements were not available. The current results should therefore be considered as preliminary in this field, and methodological studies are needed to establish good measurement of the presumed accessibility of foods in the home, as measured by adolescents and by parents.

Single items were predominately used to measure determinants of behaviour in the present study. This was a consequence of keeping the questionnaire within a reasonable extent, when addressing both multiple behaviours and their related determinants simultaneously [165]. The use of single items to assess determinants of behaviour may be less reliable and valid due to measurement error and greater score variation, than using multiple-item measures as proposed in psychometrics [175]. However, a single measurement may be sufficient when measuring a context not directly linked to an individual characteristic [175], such as availability in the home. Multiple items measuring parental regulation of TV/DVD time and PC/game time were available in the HEIA study. However, in order to keep as many parents as possible in the present study only single item measurements were included in the analyses. This was because missing appeared as a problem across the items, even when allowing for missing in one of the construct items. Thus all facets of parental regulation may not be captured, that may be a limitation in the present analyses. As few studies are available to make comparisons of the results, future studies should possibly include the use of multiple-item scales in order to verify the present analyses. Moreover, parental regulation of TV/DVD time obtained low test-retest correlation coefficients, indicating less reliability of these measurements. However, the larger sample size the larger tolerance of a less reliable instrument [176], and thus we believe the reliability of these measurements to be acceptable for the present analyses.

4.1.3 Evaluating the magnitude of tracking

Several methods can be used to evaluate the magnitude of tracking, which make comparison of tracking difficult [59]. For the tracking of continuous variables, Pearson and Spearman's rank correlation coefficient have been widely used [177]. However, significance testing of a tracking coefficient does not provide information about the magnitude of tracking, but rather

that tracking are significantly different from zero [59]. Continuous outcome variables can be divided into percentile groups or into groups according to pre-determined cut-off points [177]. By introducing cut-offs on continuous variables, it is important to notice that some information will be lost when the outcome variables are grouped [177]. For dichotomous and categorical variables a predictive value and relative probability can be calculated [177]. However, it is important to take into consideration that the higher possibility of tracking in extreme groups simply may be caused by statistical property when interpreting the proportion of tracking [59]. Thus tracking can only be concluded when the tracking proportion is significantly different between groups [59]. A commonly used measurement is also tracking by Cohen's Kappa [59]. As this method is weighing movement between groups equally [58], Cohen [178] further developed a correlation coefficient of weighted Kappa accounting for distances of movements over time.

More methodologies are available in order to measure tracking of several longitudinal time points [177]. As the present study conducted the first follow-up already after eight months, small changes were expected between T0 and T1. Nevertheless, the transition period between children and adolescence is a critical period during which rapid changes are expected to occur [1]. As tracking is influenced by the duration of follow-up it is important to take into account that a high tracking coefficient during a short period of time does not necessarily indicate more tracking than a modest tracking coefficient during a longer time span, when comparing the results [59]. Tracking patterns can illustrate evidence of tracking by investigating changes in mean group behaviours over several time points as the maintenance of a relative position in rank [160]. However, a tendency of regression towards the mean will necessarily occur in such analyses, and needs to be accounted for when interpreting the results. This phenomena is a result of the higher statistical probability of an extreme value at one time point being more likely to become less extreme on the next occasion when there is a non-perfect correlation among the two variables, which means almost all of the time [179].

4.1.4 Approaches to mediation analyses

The assessment of mediation is conducted by a series of regression analyses, and different approaches are proposed to statistical mediation analyses [106, 162, 163, 180]. Baron and Kenny's casual step approach from 1986 [162], is the most widely used method for mediation analyses [106, 181]. However, lately several limitations of this approach have been discussed,

especially in regards to the requirement of a significant association in the total effect (c-path) for mediation to occur [106, 163, 181, 182]. The product of coefficients approach to mediation analyses is thus recommended, because it can establish mediation even with the absence of a total effect [181, 183], and is therefore more suitable of detecting mediation in smaller samples [163, 184]. As stated by Shrout and Bolger [182], when a casual process becomes more distal the effect size normally gets smaller because of possible intermediate effects on the relationship. Finally, it is argued that results of mediation analyses should be reported even in the presence of null findings since they have the potential to extend our understanding of behaviour change [181].

In order to test for significance of the mediation effect a 95% confidence interval is needed, which can be obtained by using the Sobel's test that are suggested to be accurate in models with more than one mediator if the sample size exceeds 100-200 [106, 163]. However, this approach assume that both the a-path and the b-path follow a multivariate normal distribution as well as a normal distribution of total and mediation effects, which is rarely true [163]. By using bootstrapping methods, with preferably resampling of 1000 independent samples, the distribution will be examined empirically and thus this problem will be avoided [182]. Percentile bootstrap confidence intervals is then calculated, which reduces the problems with Type 1 errors and power when used in hypothesis testing [163]. Bias-corrected bootstrap tests are furthermore recommended in order to increase the power of the analyses [163, 164].

4.2 Interpretation of results

The main findings of this thesis will be discussed in light of the methodological aspects considered. Firstly the tracking of dietary behaviours will be addressed, followed by social differences by parental education in adolescents' prospective intake of SSB and screen time behaviours. Subsequently possible mediating effects of the home environment on the relationship between parental education and adolescents' prospective intake of soft drinks and screen time behaviours will be presented. Finally, gender related parent-child relationships of screen time will be assessed.

4.2.1 Tracking of dietary behaviours (Paper I)

Childhood and adolescence are key periods in life for the development of long-lasting dietary behaviours [5, 70, 72]. Moreover, adolescence is a period of rapid behavioural, psychological

and biological development that may influence such behaviours [5]. Studying the tracking of dietary behaviours during this age may help determine the proper timing of interventions to target behaviour changes, and thus establish good opportunities for a healthy diet in the future.

The present study found fair to moderate tracking of fruits and vegetables between the ages of 11 and 13 years. The findings is in line with previous studies [65, 185-187], although comparability between tracking studies is complicated due to differences in methods used and duration of follow-up [59]. The results indicate that low consumers of fruits and vegetables are likely to remain low consumers during this age, and that interventions aiming to increase intake should be aimed at even younger children. An Australian study investigating the tracking of fruit and vegetables in younger children, indicated high stability from the age of six years with follow-up after three and five years [186]. These findings may suggest that adolescents' dietary behaviours of fruit and vegetable intake are established even before the age of six. However, more studies are needed to investigate the critical age of when such dietary habits are initiated.

Results from the present study further add to the limited knowledge regarding tracking patterns of unhealthy dietary behaviours, by consumption of snacks, soft drinks and squash in children during the transition into adolescence. Fair tracking of snacks was observed from the age of 11 to 13 years, based on two questions measuring the usual consumption of chocolates/sweets and salty snacks. Previous findings are inconsistent [185, 186, 188], however the definition of snacks varied between studies. A recent Australian study reported moderate to high stability of the intake of sweet and sour energy dense snacks among both six year olds and 11 year olds when followed up after three and five years [186]. The intake of snacks were then measured by 13 items consumed during the last week [186]. Tracking depends on the categorical grouping of variables [177], which may have influenced the results of the present study where tracking groups were based on quite narrow intervals. However, corresponding correlation coefficients were obtained when looking at snacking as a grouped variable by Cohen's weighted Kappa and as a continuous variable by Spearman's rank correlation (Cohen's κ_w=0.3, Spearman's r_s=0.3). Thus the present results are through multiple analyses believed to reflect the tracking of chocolates, sweets and salty snacks among these adolescents between the ages of 11 and 13 years.

Fair to moderate tracking were observed for the consumption of soft drinks and squash between the ages of 11 to 13 years. Previous findings among Swedish nine year olds reported low tracking of SSB over six years [185]. Inconsistency in results may be due to the existing methodological differences in defining variables, as well as methodological differences as data was collected through a 24 hour recall [185]. Importantly, the age span of which adolescents were measured differed between studies, as well as the time period investigated. Hence, more studies are needed in order to investigate the magnitude of tracking of energy dense snacks and SSB among children during transition into adolescence.

The overall small changes and the fair to moderate tracking observed in dietary behaviours from the age of 11 to 13 years in the present study may be anticipated, because in general we expect small changes during such a short time period. However, rapid changes are expected to occur in children during transition into adolescents, and a significant increase in the intake of soft drinks was observed during the 20 months of assessment. Thus, the adolescents may be more independent in their preferences at the age of 13 years, and the amount of pocket money may have increased allowing the adolescents to buy what they want. Further understanding of determinants influencing adolescents' prospective soft drink intake is therefore important during this age, to be able to prevent negative behaviour changes to occur, and further influence future health. However, few studies have examined determinants of adolescents' intake of SSB longitudinally [89, 189].

4.2.2 Social inequalities by parental education (Paper I - III)

Social inequalities are consistently observed in adolescents' health behaviours, and parental education is an important indicator of such differences [190, 191]. However, inconsistent findings have been reported for the relationship between parental education and unhealthy dietary behaviours [75] and screen time [122] among adolescents. Few studies have investigated such relationships longitudinally.

Sugar sweetened beverages (SSB)

The present study found the consumption of soft drinks to significantly increase among boys and girls between the ages of 11 to 13 years. Significant differences were furthermore found between level of parental education and adolescents' soft drink intake at both ages, where a higher level of education was associated with a lower consumption. Regression analyses

confirmed that parental education predicted the intake of soft drinks among 13 year olds, when adjusting for gender. However, by investigating change in behaviour over time, no such relationship was observed between parental education and the change in adolescents' soft drink intake between the ages of 11 and 13 years, when adjusting for gender and weight status. The results may indicate that differences by parental education in adolescents' soft drink intake may already be established before the age of 11 years, and that these differences do not necessarily increase between the ages of 11 and 13 years. Other studies investigating prospective relationships between parental education and adolescents' soft drink consumption were not found, and more longitudinal studies are needed in order to conclude on such relationships.

The present study further reported differences by parental education in adolescents' tracking of soft drinks and squash during the 20 months of assessment. Adolescents having parents with a high education level had higher odds of consuming a stable low than a stable high intake of soft drinks and squash between the ages of 11 to 13 years, when compared to participants having parents of a lower level of education. Tracking in dietary intakes among Chinese children aged 6-13 years, and followed-up after six years, indicated that mothers' nutritional knowledge, health consciousness and exposure to media may be more important than maternal education in predicting dietary tracking [65]. However, the results are hardly comparable to the present results due to the study population from a developing country undergoing rapid social and economic transitions [65]. The results of the present thesis imply that differences by parental education were important in adolescents' maintenance of soft drink and squash consumption among these semi-urban adolescents' of highly educated parents. Hence, it is important to investigate possible modifiable factors of parental education on adolescents' prospective intake of SSB, in order to identify target variables to include in future interventions aimed at reducing social inequalities in consumption.

Screen time behaviours

Previous findings from the HEIA cohort study investigating screen time behaviours among adolescents, reported no significant associations between parental education and total screen time (total of TV/DVD and PC/games) at the age of 11 years [159]. However, parental education was found to predict girls' total screen time among 13 year olds, with an inverse relationship [159]. By investigating TV/DVD and PC/games as separate behaviours, the present study concurrently observed no cross-sectional differences by parental education in

adolescents' time spent on TV/DVD or PC/games at the age of 11 years. Although, significant differences were found between level of parental education and adolescents' TV/DVD and PC/game time at the age of 13 years. Such relationships were further examined by regression analyses, when adjusting for adolescents' gender, weight status and living status. The results showed that parental education predicted time spent on PC/games among adolescents at the age of 13 years. However, a relationship was no longer observed in adolescents' prospective time spent on TV/DVD. A previous study reported inconsistent results on the prospective relationship between parental education at the age of 13 years and girls' television viewing and videogame playing after six months [192], and no relationships were reported between parental education level at the age of 9-12 years and adolescents' television viewing, playing video games or computer use at the age of 14 years and older [193].

The lack of influence from parental education on adolescents' prospective TV/DVD time in the present study may be caused by the fact that social differences in adolescents' prospective TV/DVD time were less important in this group of 11-13 year olds. Although, the findings may indicate that such differences may become more predominant by age. A recent cross sectional study among Norwegian 6-15 year olds reported that children of parents with higher education were associated with less screen time as well as a lower frequency of television in the child's bedroom [194]. Other factors in the home environment are consistently shown to be important correlates of adolescents' television viewing, such as such as parental modelling, regulation, availability and accessibility of televisions in the home [90, 122]. Hence, other determinants in the home may be stronger in influencing the adolescents' prospective behaviour during adolescence than the highest level of education among parents. However, the level of parental education was high in this group of 11 year olds, and analyses were based on a binominal variable which may not capture all gradients of parental education. More research is needed in order to investigate the prospective relationship between parental education and different screen time behaviours during adolescence.

Tracking of adolescents' screen time behaviours have furthermore been investigated in the HEIA cohort study, implying fair to moderate tracking between the ages of 11 to 13 years [159]. However, parental education was not found to be associated with tracking of adolescents' total screen time between the ages of 11 and 13 years [159]. A significant increase in adolescents' TV/DVD and PC/game time was observed during the 20 months of assessment, and the study concluded that variables from other domains may be more

important than sociodemographic factors in influencing the maintenance of total screen time in adolescents of this age [159]. There is thus a need to look into possible modifiable determinants of screen time in children during transition into adolescence.

4.2.3 Mediating effects of the home environment (Paper II and III)

The relationship between parental education and dietary and sedentary behaviours may be explained through determinants in the home environment [75, 122], but this has not been much studied. There is furthermore a lack of longitudinal studies and studies that investigate multiple determinants concurrently [111], which is strongly needed to take into account the complex interaction of influences of the home from different environmental levels [119, 123].

Accessibility and availability of soft drinks in the home

The present study observed a significant mediation effect of perceived accessibility of soft drinks measured by adolescents and mothers. The mediators explained the relationship of parental education predicting adolescents' soft drink consumption at the age of 13 years. The results indicate that a lower level of education was related to a higher accessibility of soft drinks, which was further predicting a higher soft drink intake between the ages of 11 and 13 years. A significant direct effect was furthermore found between parental education and the prediction of adolescents' soft drink intake (c'-path), indicating that this relationship still existed after adjusting for the possible mediating effects (partial mediation). Availability of soft drinks at home was not found to mediate such relationship, because no significant difference by parental education was observed. Perceived accessibility of soft drinks measured by fathers was no longer found to be a significant mediator after adjusting for adolescents' and mothers' reports. This was due to a weaker relationship between paternal perceived accessibility and adolescents' prospective soft drink intake, and may indicate that mothers are more attentive in regards to the accessibility of soft drinks at home. However, a moderate correlation was found between parental reports of perceived accessibility (r=0·47), and caution should therefore be made before disregarding the importance of perceived accessibility of soft drinks reported by fathers.

The results imply that perceived accessibility measured by adolescents and parents may be important determinants to consider in interventions aiming to reduce differences by parental education in adolescents' soft drink consumption, and should be further investigated. Previous

findings are scarce, however a recent cross-sectional study among preschool children in Belgium found the relationship between parental education and consumption of soft drinks to be almost entirely mediated by accessibility at the dinner table, availability in the home and permissiveness [195]. Another cross-sectional study suggested perceived accessibility at home and modelling (descriptive norms from important others) among Norwegian 16 year olds to partly mediate the relationship between adolescents' future educational plans and soft drink consumption [196]. Furthermore, cross-sectional analyses indicated that the relationship between home environmental variables of availability, accessibility, parental modelling and parental rules, as measured by 14 year olds, and adolescents' soft drink consumption was partly mediated by habit strength and intention to consume soft drinks within the next six months [197]. Other factors in the adolescents' home environment may be involved in explaining the relationship between parental education and adolescents' prospective soft drink intake, and caution should therefore be taken before a conclusion can be made. As the present measurement of perceived accessibility among parents may have be influenced by parental rules, the results may indicate a possible influence of parental education on parental house rules that further affect adolescents' soft drink intake over time. Future mediation analyses investigating possible mediating effects of the home environment in the relationship between parental education and adolescents' soft drink consumption should include both sociocultural and physical environmental variables as well as examine possible moderating individual determinants.

Parental modelling and regulation of screen time

A significant mediation effect of maternal and paternal modelling of adolescents' TV/DVD time was observed in the present analyses. The mediators were found to explain the relationship of parental education predicting adolescents' TV/DVD time at the age of 13 years. Indicating that a lower level of parental education was related to more parental TV/DVD time, which was further predicting more TV/DVD time between the ages of 11 and 13 years. However, no total or direct effect of parental education on adolescents' TV/DVD time was observed. The level of parental education was high in the included sample of participants, as well as measured by the educational level of the parent with the highest educational level. This may have underestimated the differences by parental education in this sample of participants, as the participating parents may be seen as more health conscious than the parents that did not participate.

The results indicate that the relationship between parental education and adolescents' prospective time spent on TV/DVD is explained through parental modelling in this sample of 11 to 13 year olds. Thus, parental modelling of TV/DVD time may be important to consider when intervening on adolescents' TV/DVD time across social groups. However, no mediation by parental regulation of adolescents' prospective TV/DVD time was observed, as differences in regulation by parental education were not found. The findings are supported by a recent cross-sectional study indicating that restrictions of children's television viewing seemed less important as a mediator between maternal education and 11 year old children's television viewing than among six year olds television viewing [198]. It is important to notice that the present study questioned the reliability of measuring parental TV/DVD regulation as a single construct. Although, the lack of test-retest reliability among parents may be somewhat explained by less established rules related to adolescents' TV/DVD time than for PC/game time. Thus, further studies should investigate the role of parental regulation in the casual relationship between parental education and adolescents' TV/DVD time. A recent cross-sectional study further found number and placement of television in the home to be the strongest mediators of the relationship between maternal education and 11 year old children's television viewing [198]. Further studies should additionally investigate other possible influences of the home food environment on adolescents' TV/DVD time, such as the availability and accessibility in the home.

The present study did neither find parental modelling nor regulation to mediate the relationship of parental education on adolescents' prospective PC/game time. These results imply that parental modelling is less important as an intermediate variable when explaining differences by parental education in adolescents' prospective PC/game time. Few studies are found to investigate associations of the home environment on adolescents' time spent on PC/games [122]. The results may be reflect by the larger differences in time spent on PC/games between parents and adolescents, than what was observed for TV/DVD time. Hence, adolescents' may be more independent in their time spent on PC/games, which can be more influenced through social contexts with siblings and friends rather than with parents. Other factors in the home environment may be more important mediators of adolescents' time spent on PC/games by parental education, and thus availability and accessibility of computers in the home, presence and interaction with siblings and friends should be a matter for further investigation.

4.2.4 Parent-child gender relationships (Paper III)

Previously reviewed research on parent-child relationships indicate that mothers invest more time and are more involved in parenting during adolescence compared to fathers, and are thus considered closer to adolescents of both genders [199]. However, while mothers are more engaged in care giving, the fathers tend to be more involved in leisure activities [199]. The HEIA study previously reported gender relationships of overweight and weight circumference between both parents with their sons and between mothers and daughters at the age of 11 years [147]. The same gender relationships were found among 11 year old adolescents' consumption of SSB, but such findings were less consistent for the intake of fruits and vegetables [200].

The present study found correlations between mothers' and fathers' TV/DVD time with boys and girls TV/DVD time at both ages of 11 and 13 years, and the associations seemed to become stronger by age. A steady increase of time spent watching television in gender dyads of parents and adolescents has been reported from the age of 9-10 years to the age of 15-17 years [45]. Previous findings have furthermore reported that parents spend less time with their children in other social contexts as they grow older [45]. The present findings may suggest that adolescents spend more time on TV/DVD with their parents as a shared activity when they grow older, probably as a result of spending time together as a family and due to prolonged waking hours.

The present study furthermore observed cross-sectional associations between mothers and their sons PC/game time and fathers and their daughters PC/game time at the age of 11 years. The evidence on gender relationships of adolescents' use of computer and electronic games is limited, but a previous cross-sectional study among Portuguese 7 to 10 year olds consistently showed that paternal television viewing was significantly related to their daughters' PC and electronic game time during weekends [201]. Correlations in gender dyads of parents' and adolescents' time spent on PC/games were no longer observed at the age of 13 years. The results may reflect the fact that time spent on PC/games is less of a shared activity among parents and adolescents, and thus less influenced by parental behaviours when adolescents grow older.

These results indicate that the fathers are more important in the adolescents screen time habits in both genders, than what was observed for these adolescents' dietary behaviours by Bjelland

et. al. [200]. It is important to notice that most previous research has been focusing on the mother as a representative of parents' and excluded the role of fathers in the home environment [141]. Hence, important cross gender relationships between parents and adolescents may exist within the different EBRB. More research is needed in order to identify possible prospective gender specific influences of parental modelling on children's screen time when growing into adolescence.

5 CONCLUSION

This thesis suggests that promotion of healthy dietary behaviours at an early age is important to prevent the establishment of unfavourable dietary behaviours later in adolescence. Fair to moderate tracking of the dietary intake of fruits, vegetables, snacks, soft drinks and squash was observed among boys and girls between the ages of 11 and 13 years. The intake of soft drinks furthermore increased significantly between these ages. Availability and perceived accessibility of soft drinks at home, as measured by adolescents, mothers and fathers, were found to predict an increased intake between the ages of 11 and 13 years. These results indicate that early adolescence is a critical phase for the onset of soft drink consumption. Availability and perceived accessibility of soft drinks at home may be important determinants to consider preventing an increase in intake over time, and positively influencing future health.

An inverse association was found in both genders between level of parental education and level of tracking in adolescents' soft drink and squash consumption, as higher odds of consuming a stable low than a stable high intake was observed among those with a higher level of parental education. The results imply that inequalities by parental education in adolescents' consumption of soft drink and squash were maintained from the age of 11 to 13 years. A higher level of parental education furthermore predicted a lower intake of soft drinks among 13 year olds. However, no association was seen between parental education and the change in adolescents' soft drink intake between the ages of 11 and 13 years, indicating that differences by parental education were already established before the age of 11 years. Moreover, perceived accessibility of soft drinks at home, as measured by adolescents and mothers, was found to be important mediators in the relationship of parental education predicting adolescents' soft drink intake, by increasing the consumption from age 11 to age 13. Thus, these may be important target variables in order to reduce adolescents' prospective soft drink intake across social groups.

Results from the present thesis showed cross-sectional and longitudinal relationships in gender dyads of parents and adolescents' screen time. Both parents' TV/DVD time was associated with adolescents' TV/DVD time among boys and girls at the age of 11 and 13 years. Opposite gender dyads were observed for PC/game time at the age of 11 years, but the association was not seen in either gender at the age of 13 years. These findings may suggest

that adolescents spend more time on TV/DVD with their parents as a shared activity, while time spent on PC/games is less of a shared activity among parents' and adolescents when they grow older.

Parental modelling of TV/DVD time further predicted more time spent on TV/DVD and parental regulation predicted less time spent on TV/DVD between the ages of 11 and 13 years, while a higher level of parental education predicted less time spent on PC/games among adolescents. Suggesting that these may be important home environmental determinants to consider when aiming to reduce adolescents' prospective TV/DVD and PC/game time. However, other factors in the home environment may influence adolescents' prospective screen time and should be included in future studies, such as the availability and accessibility of screens in the home. Parental modelling may further be an important target variable in reducing adolescents' prospective TV/DVD time across social groups, as both maternal and paternal modelling was found to be important mediators of the relationship between parental education and adolescents' prospective TV/DVD time among 13 year olds.

5.1 Implications for further research

Changes in energy balance-related behaviours may occur during key life stages such as children growing into adolescence. There is limited evidence in regards to the tracking of dietary behaviours between childhood and adolescence. The present findings indicated tracking of dietary behaviours between the ages of 11 and 13 years, and thus highlight the importance of starting before the age of 11 years to prevent the establishment of unfavourable dietary behaviours later in adolescence. Hence, the tracking of dietary behaviours among children should be further investigated. Moreover, few studies have investigated changes in intake of energy dense and sugary foods among adolescents over time, and thus more longitudinal studies should be conducted.

Relatively few studies have included variables in the home environment as measured by parents. Even less evidence is found including both mothers and fathers reports as most previous research has been focusing on the mother as a representative of parents, and thus excluded the role of fathers in the home environment. The present study found novel cross-sectional and longitudinal relationships of different screen time behaviours in gender dyads of parents and adolescents, indicating that mothers and fathers may influence their children

differently. Hence, important parent-child relationships may exist in adolescents' EBRB that are currently not understood, indicating a need for further studies.

The present study is furthermore among the first to investigate the prospective relationship between parental education and adolescents dietary and screen time behaviours. More studies are needed in order to conclude on the association between parental education and tracking of dietary behaviours in children during the transition into adolescence. Moreover, few studies have investigated the prospective relationship of parental education on adolescents' soft drink consumption as well as screen time during adolescence. Hence, more evidence is needed in order to draw a conclusion. Important determinants in the home environment were found to influence adolescents' prospective intake of soft drinks and time spent on TV/DVD and PC/games. Both availability and accessibility in the home, as well as parental modelling and regulation seems to be important factors that should be included in further analyses.

5.2 Implications for health promotion

In 2010 the Norwegian Directorate of Health presented the "National guidelines for prevention, assessment and treatment of overweight and obesity in children and adolescents" [50]. These guidelines aimed to prevent the onset of overweight among children and adolescents by establishing a healthy lifestyle at an early age, as well as to identify children and adolescents at risk of an unhealthy weight development. The importance of involving the family and surroundings of the child in collaboration with the primary school health service is highlighted, to be able to influence their daily dietary and activity habits. The present thesis contributes with knowledge in regards to the parental role in young adolescents' dietary and screen time behaviours, which further may influence weight status. Furthermore, important gender relationships between parents' and adolescents' behaviours are highlighted. Even though mothers are found to be important providers and role models for their children, fathers seem to have a great role in adolescents' health behaviours that has previously been less highlighted, probably due to lack of such data. Involving both parents in prevention strategies of an unhealthy lifestyle among adolescents might be of importance in regards to adolescents' weight status. By increasing parental awareness of the importance of determinants in the home, such as availability and accessibility of soft drinks, modelling and regulation of TV/DVD time, parents may to a larger degree contribute in reducing adolescents' intake of soft drinks and time spent on TV/DVD, respectively. Raising awareness of these

determinants, resulting in a healthier lifestyle, may further have implications for adolescents' prospective behaviours, and thus influence future health.

The Norwegian white paper "National strategy to reduce social inequalities in health 2006-07" argues that to reduce social inequality in health it is important to reduce inequality in diet, physical activity, smoking and other health-related behaviours, and to focus the efforts on structural causes of these behaviours [49]. This thesis contributes to the National strategy by highlighting the importance of parental education in dietary and screen time behaviours during adolescence, of which differences in adolescents' prospective soft drink consumption and PC/game time in particular should be emphasized. Moreover, the mediating effect of home environmental variables in explaining the relationship between parental education and adolescents' health behaviours was observed longitudinally. Thus, factors in the home environment were found to be related to adolescents' dietary and screen time behaviours, and may furthermore be important determinants to target in interventions aiming to reduce social differences in such behaviours among Norwegian 11 to 13 year olds. By targeting the accessibility of soft drinks at home, adolescents' soft drink intake can be reduced across level of parental education. Subsequently, targeting parental modelling of time spent on TV/DVD may be an important target variable to consider in interventions aiming to reduce TV/DVD time across social groups of parental education. This may be done by involving the family and surroundings of the adolescents in collaboration with the primary school health service.

REFERENCES

1. Sawyer SM, Afifi RA, Bearinger LH, Blakemore SJ, Dick B, Ezeh AC, Patton GC: **Adolescence: a foundation for future health**. *Lancet* 2012, **379**(9826):1630-1640.
2. Ells LJ, Campbell K, Lidstone J, Kelly S, Lang R, Summerbell C: **Prevention of childhood obesity**. *Best practice & research Clinical endocrinology & metabolism* 2005, **19**(3):441-454.
3. World Health Organization: **Young people's health: a challenge for society**. In: *Tecnical Report Series 731*. Geneva: WHO; 1986.
4. Jago R, Fox KR, Page AS, Brockman R, Thompson JL: **Parent and child physical activity and sedentary time: do active parents foster active children?** *BMCPublic Health* 2010, **10**:194.
5. Due P, Krolner R, Rasmussen M, Andersen A, Trab DM, Graham H, Holstein BE: **Pathways and mechanisms in adolescence contribute to adult health inequalities**. *ScandJPublic Health* 2011, **39**(6 Suppl):62-78.
6. Viner RM, Ozer EM, Denny S, Marmot M, Resnick M, Fatusi A, Currie C: **Adolescence and the social determinants of health**. *Lancet* 2012, **379**(9826):1641-1652.
7. Golan M, Crow S: **Parents are key players in the prevention and treatment of weight-related problems**. *NutrRev* 2004, **62**(1):39-50.
8. Catalano RF, Fagan AA, Gavin LE, Greenberg MT, Irwin CE, Jr., Ross DA, Shek DT: **Worldwide application of prevention science in adolescent health**. *Lancet* 2012, **379**(9826):1653-1664.
9. World Health Organization: **Diet, Nutrition and the prevention of Chronic Diseases**. In: *Technical Report Series 916.* Geneva: WHO; 2003.
10. 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):123-146.
11. World Cancer Research Fund, American Insitute for Cancer Research: **Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective**. In. Washington DC: AICR; 2007.
12. Lakshman R, Elks CE, Ong KK: **Childhood obesity**. *Circulation* 2012, **126**(14):1770-1779.
13. Singh AS, Mulder C, Twisk JW, Van MW, Chinapaw MJ: **Tracking of childhood overweight into adulthood: a systematic review of the literature**. *ObesRev* 2008, **9**(5):474-488.
14. Reilly JJ, Methven E, McDowell ZC, Hacking B, Alexander D, Stewart L, Kelnar CJ: **Health consequences of obesity**. *ArchDisChild* 2003, **88**(9):748-752.
15. World Health Organization: **The challenge of obesity in the WHO Europe Region and the strategies for response**. In. Copenhagen: WHO; 2007.
16. World Health Organization: **Obesity: preventing and management the global epidemic.** In: *Technical Report Series 894.* Geneva: WHO; 2000.
17. World Health Organization: **Obesity: preventing and managing the global epidemic**. In. Geneva: WHO; 1998.
18. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH: **Establishing a standard definition for child overweight and obesity worldwide: international survey**. *BMJ* 2000, **320**(7244):1240-1243.
19. Lobstein T, Jackson-Leach R: **Estimated burden of paediatric obesity and co-morbidities in Europe. Part 2. Numbers of children with indicators of obesity-related disease**. *IntJPediatrObes* 2006, **1**(1):33-41.

20. Reilly JJ: **Descriptive epidemiology and health consequences of childhood obesity**. *BestPractResClinEndocrinolMetab* 2005, **19**(3):327-341.
21. Bjorge T, Engeland A, Tverdal A, Smith GD: **Body mass index in adolescence in relation to cause-specific mortality: a follow-up of 230,000 Norwegian adolescents**. *AmJEpidemiol* 2008, **168**(1):30-37.
22. Wang Y, Lobstein T: **Worldwide trends in childhood overweight and obesity**. *IntJPediatrObes* 2006, **1**(1):11-25.
23. Jackson-Leach R, Lobstein T: **Estimated burden of paediatric obesity and co-morbidities in Europe. Part 1. The increase in the prevalence of child obesity in Europe is itself increasing**. *IntJPediatrObes* 2006, **1**(1):26-32.
24. International Obesity Task Force: **Obesity in Europe: The case for action**. In.: European Association for the study of Obesity 2002.
25. Kautiainen S: **Trends in adolescent overweight and obesity in the Nordic countries**. *ScandJNutr* 2005, **49**(1):4-14.
26. Brug J, van Stralen MM, te Velde SJ, Chinapaw MJ, de BI, Lien N, Bere E, Maskini V, Singh AS, Maes L *et al*: **Differences in Weight Status and Energy-Balance Related Behaviors among Schoolchildren across Europe: The ENERGY-Project**. *PLoSOne* 2012, **7**(4).
27. Wijnhoven TM, van Raaij JM, Spinelli A, Rito AI, Hovengen R, Kunesova M, Starc G, Rutter H, Sjoberg A, Petrauskiene A *et al*: **WHO European Childhood Obesity Surveillance Initiative 2008: weight, height and body mass index in 6-9-year-old children**. *PediatrObes* 2012.
28. Anderssen SA, Kolle E, Steene-Johannessen J, Ommundsen Y, Andersen LB: **[Physical activity among Norwegian children and adolescents]**. In. Oslo: The Norwegian Directorate of Health; 2008.
29. Kautiainen S, Rimpela A, Vikat A, Virtanen SM: **Secular trends in overweight and obesity among Finnish adolescents in 1977-1999**. *IntJObesRelat Metab Disord* 2002, **26**(4):544-552.
30. Lissner L, Sohlstrom A, Sundblom E, Sjoberg A: **Trends in overweight and obesity in Swedish schoolchildren 1999-2005: has the epidemic reached a plateau?** *ObesRev* 2010, **11**(8):553-559.
31. Currie C, Gabhainn SN, Godeau E, Roberts C, Smith R, Currie D, Picket W, Richter M, Morgan A, Barnekow V: **Inequalities in young people's health. Health Behaviours in school-aged children (HBSC) study: International report from the 2005/2006 survey**. In: *Healthy Policy for Children and Adolescents.* Copenhagen; 2008.
32. Currie C, Zanotti C, Morgan A, Currie D, de Looze M, Roberts C, Samdal O, Smith ORF, Barnekow V: **Social determinants of health and well-being among young people. Health Behaviours in school-aged children (HBSC) study: International report from the 2009/2010 survey**. In: *Healthy Policy for Children and Adolescents.* Copenhagen; 2012.
33. Andersen LF, Lillegaard IT, Overby N, Lytle L, Klepp KI, Johansson L: **Overweight and obesity among Norwegian schoolchildren: changes from 1993 to 2000**. *ScandJPublic Health* 2005, **33**(2):99-106.
34. Hovengen R, Strand BH: **[The Child Growth Study - Childrens growth in Norway 2010]**. In. Oslo: Norwegian Institute of Public Health; 2011.
35. Norvegian Institute of Public Health: **[The Norwegian Child Growth Study 2008-2012: Stable weight development among children]**. In.: Norvegian Institute of Public Health; 2013.

36. 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):835-846.
37. 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 nutrition* 2010, **13**(10A):1680-1687.
38. Reilly JJ: **Evidence-based obesity prevention in childhood and adolescence: critique of recent etiological studies, preventive interventions, and policies**. *Advances in nutrition* 2012, **3**(4):636S-641S.
39. Hetherington MM, Cecil JE: **Gene-environment interactions in obesity**. *Forum Nutr* 2010, **63**:195-203.
40. Lee YS: **The role of genes in the current obesity epidemic**. *AnnAcadMedSingapore* 2009, **38**(1):45-43.
41. Hill JO, Peters JC: **Environmental contributions to the obesity epidemic**. *Science* 1998, **280**(5368):1371-1374.
42. Oude LH, Baur L, Jansen H, Shrewsbury VA, O'Malley C, Stolk RP, Summerbell CD: **Interventions for treating obesity in children**. *CochraneDatabaseSystRev* 2009(1):CD001872.
43. Lobstein T, Baur L, Uauy R: **Obesity in children and young people: a crisis in public health**. *ObesRev* 2004, **5 Suppl 1**:4-104.
44. Swinburn B: **Obesity prevention in children and adolescents**. *Child AdolescPsychiatrClinNAm* 2009, **18**(1):209-223.
45. World Health Organization: **Obesity: preventing and management the global epidemic. Report of a WHO Consultation**. In., vol. 894. Geneva: WHO; 2000.
46. National Council on Nutrition and Physical Activity: **[Weight - Health]**. In: *Report 1/2000*. Oslo; 2000.
47. Norwegian Ministery of Social Affairs: **Prescriptions for a Healthier Norway: A broad policy for public health**. In: *Report No 16 (2002-2003) to the Storting.* 2003.
48. Norwegian Ministery of Health and Care Services: **The Norwegian action plan on Nutrition (2007-2011): Recipe for a healthier diet**. In. Oslo: Norwegian Ministries; 2007.
49. Norwegian Ministery of Health and Care Services: **A National strategy to reduce social inequalities in health**. In: *Report No 20 (2006-2007) to the Storting.* 2007.
50. Norwegian Directorate of Health: **[National guidelines for prevention, assessment and treatment of overweight and obesity in children and adolescents]**. In., vol. IS-1734. Oslo; 2010.
51. Cislak A, Safron M, Pratt M, Gaspar T, Luszczynska A: **Family-related predictors of body weight and weight-related behaviours among children and adolescents: a systematic umbrella review**. *Child: care, health and development* 2012, **38**(3):321-331.
52. Swinburn B, Egger G, Raza F: **Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity**. *PrevMed* 1999, **29**(6 Pt 1):563-570.
53. Waters E, de Silva-Sanigorski A, Hall BJ, Brown T, Campbell KJ, Gao Y, Armstrong R, Prosser L, Summerbell CD: **Interventions for preventing obesity in children**. *CochraneDatabaseSystRev* 2011(12):CD001871.
54. 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**. *ObesRev* 2009, **10**(1):110-141.

55. Kremers SP, de Bruijn GJ, Visscher TL, Van MW, de Vries NK, Brug J: **Environmental influences on energy balance-related behaviors: a dual-process view**. *IntJBehavNutrPhysAct* 2006, **3**:9.
56. van der Sluis ME, Lien N, Twisk JW, Steenhuis IH, Bere E, Klepp KI, Wind M: **Longitudinal associations of energy balance-related behaviours and cross-sectional associations of clusters and body mass index in Norwegian adolescents**. *Public Health Nutr* 2010, **13**(10A):1716-1721.
57. Prentice-Dunn H, Prentice-Dunn S: **Physical activity, sedentary behavior, and childhood obesity: a review of cross-sectional studies**. *PsycholHealth Med* 2012, **17**(3):255-273.
58. Twisk JW, Kemper HC, Mellenbergh GJ: **Mathematical and analytical aspects of tracking**. *EpidemiolRev* 1994, **16**(2):165-183.
59. Twisk JW: **The problem of evaluating the magnitude of tracking coefficients**. *EurJEpidemiol* 2003, **18**(11):1025-1026.
60. 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):266-284.
61. Telama R: **Tracking of physical activity from childhood to adulthood: a review**. *Obesity facts* 2009, **2**(3):187-195.
62. Hallal PC, Victora CG, Azevedo MR, Wells JC: **Adolescent physical activity and health: a systematic review**. *Sports medicine (Auckland, NZ)* 2006, **36**(12):1019-1030.
63. Madruga SW, Araujo CL, Bertoldi AD, Neutzling MB: **Tracking of dietary patterns from childhood to adolescence**. *RevSaude Publica* 2012, **46**(2):376-386.
64. Biddle SJ, Pearson N, Ross GM, Braithwaite R: **Tracking of sedentary behaviours of young people: a systematic review**. *PrevMed* 2010, **51**(5):345-351.
65. Wang Y, Bentley ME, Zhai F, Popkin BM: **Tracking of dietary intake patterns of Chinese from childhood to adolescence over a six-year follow-up period**. *JNutr* 2002, **132**(3):430-438.
66. Story M, Neumark-Sztainer D, French S: **Individual and environmental influences on adolescent eating behaviors**. *JAmDietAssoc* 2002, **102**(3 Suppl):S40-S51.
67. Laska MN, Murray DM, Lytle LA, Harnack LJ: **Longitudinal Associations Between Key Dietary Behaviors and Weight Gain Over Time: Transitions Through the Adolescent Years**. *Obesity(SilverSpring)* 2011.
68. Yngve A, Wolf A, Poortvliet E, Elmadfa I, Brug J, Ehrenblad B, Franchini B, Haraldsdottir J, Krolner R, Maes L *et al*: **Fruit and vegetable intake in a sample of 11-year-old children in 9 European countries: The Pro Children Cross-sectional Survey**. *AnnNutrMetab* 2005, **49**(4):236-245.
69. Overby NC, Andersen LF: **[Ungkost 2000: A national dietary survey among Norwegian 4th and 8th graders]**. In. Oslo: The Norwegian Ministry of Health and Social Affairs 2002.
70. Moreno LA, Rodriguez G, Fleta J, Bueno-Lozano M, Lazaro A, Bueno G: **Trends of dietary habits in adolescents**. *Crit RevFood SciNutr* 2010, **50**(2):106-112.
71. Lytle LA, Seifert S, Greenstein J, McGovern P: **How do children's eating patterns and food choices change over time? Results from a cohort study**. *AmJHealth Promot* 2000, **14**(4):222-228.
72. Cutler GJ, Flood A, Hannan P, Neumark-Sztainer D: **Major patterns of dietary intake in adolescents and their stability over time**. *JNutr* 2009, **139**(2):323-328.

73. Resnicow K, Smith M, Baranowski T, Baranowski J, Vaughan R, Davis M: **2-year tracking of children's fruit and vegetable intake**. *JAmDietAssoc* 1998, **98**(7):785-789.
74. Lake AA, Mathers JC, Rugg-Gunn AJ, Adamson AJ: **Longitudinal change in food habits between adolescence (11-12 years) and adulthood (32-33 years): the ASH30 Study**. *JPublic Health (Oxf)* 2006, **28**(1):10-16.
75. de Vet E, de Ridder DT, de Wit JB: **Environmental correlates of physical activity and dietary behaviours among young people: a systematic review of reviews**. *ObesRev* 2011, **12**(5):e130-e142.
76. Brug J, Lien N, Klepp KI, van Lenthe FJ: **Exploring overweight, obesity and their behavioural correlates among children and adolescents: results from the Health-promotion through Obesity Prevention across Europe project**. *Public Health Nutr* 2010, **13**(10A):1676-1679.
77. van Duyn MA, Pivonka E: **Overview of the health benefits of fruit and vegetable consumption for the dietetics professional: selected literature**. *JAmDietAssoc* 2000, **100**(12):1511-1521.
78. Alinia S, Hels O, Tetens I: **The potential association between fruit intake and body weight--a review**. *ObesRev* 2009, **10**(6):639-647.
79. Newby PK: **Are dietary intakes and eating behaviors related to childhood obesity? A comprehensive review of the evidence**. *JLaw MedEthics* 2007, **35**(1):35-60.
80. Samdal O, Leversen I, Torsheim T, Manger MS, Brunborg GS, Wold B: **[Public health trends among children and adolescents 1985-2005: Norwegian results from the "Health Behaviour in school-aged children" as a part of a WHO study (HBSC)]**. In., vol. 3/2009. Bergen: Department of Health Promotion and Development, University of Bergen; 2009.
81. Hilsen M, van Stralen MM, Klepp KI, Bere E: **Changes in 10-12 year old's fruit and vegetable intake in Norway from 2001 to 2008 in relation to gender and socioeconomic status - a comparison of two cross-sectional groups**. *IntJBehavNutrPhysAct* 2011, **8**:108.
82. Harrington S: **The role of sugar-sweetened beverage consumption in adolescent obesity: a review of the literature**. *JSch Nurs* 2008, **24**(1):3-12.
83. Shenkin JD, Heller KE, Warren JJ, Marshall TA: **Soft drink consumption and caries risk in children and adolescents**. *General dentistry* 2003, **51**(1):30-36.
84. Pereira SM, Tagliaferro EP, Pardi V, Cenci MS, Cortellazzi KL, Ambrosano GM, Meneghim Mde C, Pereira AC: **Sugar consumption and dental health: Is there a correlation?** *General dentistry* 2010, **58**(1):e6-e12.
85. Overby NC, Lillegaard IT, Johansson L, Andersen LF: **High intake of added sugar among Norwegian children and adolescents**. *Public Health Nutr* 2004, **7**(2):285-293.
86. Nordic Council of Ministers: **Nordic Nutrition Recommendations: Integrating nutrition and physical activity**, vol. 4th. Copenhagen: Norden; 2004.
87. Stea TH, Overby NC, Klepp KI, Bere E: **Changes in beverage consumption in Norwegian children from 2001 to 2008**. *Public Health Nutr* 2011, **15**(3):1-7.
88. Kerr MA, Rennie KL, McCaffrey TA, Wallace JM, Hannon-Fletcher MP, Livingstone MB: **Snacking patterns among adolescents: a comparison of type, frequency and portion size between Britain in 1997 and Northern Ireland in 2005**. *BrJNutr* 2009, **101**(1):122-131.
89. Pearson N, Ball K, Crawford D: **Predictors of changes in adolescents' consumption of fruits, vegetables and energy-dense snacks**. *BrJNutr* 2011, **105**(5):795-803.

90. Pate RR, Mitchell JA, Byun W, Dowda M: **Sedentary behaviour in youth**. *BrJSports Med* 2011, **45**(11):906-913.
91. Pearson N, Biddle SJ: **Sedentary behavior and dietary intake in children, adolescents, and adults. A systematic review**. *AmJPrevMed* 2011, **41**(2):178-188.
92. Tremblay MS, Leblanc AG, Kho ME, Saunders TJ, Larouche R, Colley RC, Goldfield G, Gorber SC: **Systematic review of sedentary behaviour and health indicators in school-aged children and youth**. *IntJBehavNutrPhysAct* 2011, **8**:98.
93. Salmon J, Tremblay MS, Marshall SJ, Hume C: **Health risks, correlates, and interventions to reduce sedentary behavior in young people**. *Am J Prev Med* 2011, **41**(2):197-206.
94. Spanier PA, Marshall SJ, Faulkner GE: **Tackling the obesity pandemic: a call for sedentary behaviour research**. *CanJPublic Health* 2006, **97**(3):255-257.
95. Owen N, Healy GN, Matthews CE, Dunstan DW: **Too much sitting: the population health science of sedentary behavior**. *ExercSport SciRev* 2010, **38**(3):105-113.
96. van der Horst K, Paw MJ, Twisk JW, van Mechelen W: **A brief review on correlates of physical activity and sedentariness in youth**. *MedSciSports Exerc* 2007, **39**(8):1241-1250.
97. Must A, Tybor DJ: **Physical activity and sedentary behavior: a review of longitudinal studies of weight and adiposity in youth**. *IntJObes(Lond)* 2005, **29 Suppl 2**:S84-S96.
98. Hancox RJ, Milne BJ, Poulton R: **Association between child and adolescent television viewing and adult health: a longitudinal birth cohort study**. *Lancet* 2004, **364**(9430):257-262.
99. Rey-Lopez JP, Vicente-Rodriguez G, Biosca M, Moreno LA: **Sedentary behaviour and obesity development in children and adolescents**. *NutrMetab CardiovascDis* 2008, **18**(3):242-251.
100. Canadian Paediatric Society: **Impact of media use on children and youth**. *Paediatr Child Health* 2003, **8**:6.
101. American Academy of Pediatrics: **Committee on Public Education: Children, adolescents, and television**. *Pediatrics* 2001, **107**:4.
102. Commonwealth Department of Health and Ageing: **Australia's Physical Activity Recommendations for 5-12 Year Olds**. In. Canberra; 2004.
103. Rey-Lopez JP, Vicente-Rodriguez G, Ortega FB, Ruiz JR, Martinez-Gomez D, De HS, Manios Y, Molnar D, Polito A, Verloigne M *et al*: **Sedentary patterns and media availability in European adolescents: The HELENA study**. *PrevMed* 2010, **51**(1):50-55.
104. Vereecken CA, Todd J, Roberts C, Mulvihill C, Maes L: **Television viewing behaviour and associations with food habits in different countries**. *Public Health Nutr* 2006, **9**(2):244-250.
105. Bauman AE, Sallis JF, Dzewaltowski DA, Owen N: **Toward a better understanding of the influences on physical activity: the role of determinants, correlates, causal variables, mediators, moderators, and confounders**. *AmJPrevMed* 2002, **23**(2 Suppl):5-14.
106. MacKinnon DP, Fairchild AJ, Fritz MS: **Mediation analysis**. *AnnuRevPsychol* 2007, **58**:593-614.
107. Glanz K, Bishop DB: **The role of behavioral science theory in development and implementation of public health interventions**. *Annu Rev Public Health* 2010, **31**:399-418.
108. Larson N, Story M: **A review of environmental influences on food choices**. *AnnBehavMed* 2009, **38 Suppl 1**:S56-S73.

109. Brug J, Kremers SP, Lenthe F, Ball K, Crawford D: **Environmental determinants of healthy eating: in need of theory and evidence**. *ProcNutrSoc* 2008, **67**(3):307-316.
110. van der Horst K, Oenema A, Ferreira I, Wendel-Vos W, Giskes K, van Lenthe FJ, Brug J: **A systematic review of environmental correlates of obesity-related dietary behaviors in youth**. *Health EducRes* 2007, **22**(2):203-226.
111. Ball K, Timperio AF, Crawford DA: **Understanding environmental influences on nutrition and physical activity behaviors: where should we look and what should we count?** *IntJBehavNutrPhysAct* 2006, **3**:33.
112. Bandura A: **Social foundations of thought and action - A social cognitive theory**. New Jersey: Prentice-Hall; 1986.
113. Kremers SP: **Theory and practice in the study of influences on energy balance-related behaviors**. *Patient Educ Couns* 2010, **79**(3):291-298.
114. Booth SL, Sallis JF, Ritenbaugh C, Hill JO, Birch LL, Frank LD, Glanz K, Himmelgreen DA, Mudd M, Popkin BM *et al*: **Environmental and societal factors affect food choice and physical activity: rationale, influences, and leverage points**. *NutrRev* 2001, **59**(3 Pt 2):S21-S39.
115. Sallis JF, Cervero RB, Ascher W, Henderson KA, Kraft MK, Kerr J: **An ecological approach to creating active living communities**. *Annu Rev Public Health* 2006, **27**:297-322.
116. McLeroy KR, Bibeau D, Steckler A, Glanz K: **An Ecological perspective on Health Promotion Programs**. *Health Educ Q* 1988, **15**:351-377.
117. Sallis JF, Owen N, Fisher EB: **Ecological models of health behaviour**. In: *Health behaviour and health education: Theory, research, and practice. Volume 4th*, edn. Edited by Glanz K, Rimer BK, Viswanath K. San Francisco: Jossey-Bass; 2008: 465-485.
118. Stokols D: **Establishing and maintaining healthy environments. Toward a social ecology of health promotion**. *Am Psychol* 1992, **47**(1):6-22.
119. Rosenkranz RR, Dzewaltowski DA: **Model of the home food environment pertaining to childhood obesity**. *NutrRev* 2008, **66**(3):123-140.
120. Naylor PJ, McKay HA: **Prevention in the first place: schools a setting for action on physical inactivity**. *Br J Sports Med* 2009, **43**(1):10-13.
121. Brug J, te Velde SJ, Chinapaw MJ, Bere E, de Bourdeaudhuij I, Moore H, Maes L, Jensen J, Manios Y, Lien N *et al*: **Evidence-based development of school-based and family-involved prevention of overweight across Europe: the ENERGY-project's design and conceptual framework**. *BMC public health* 2010, **10**:276.
122. 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):1380-1395.
123. Gattshall ML, Shoup JA, Marshall JA, Crane LA, Estabrooks PA: **Validation of a survey instrument to assess home environments for physical activity and healthy eating in overweight children**. *IntJBehavNutrPhysAct* 2008, **5**:3.
124. Sallis JF, Glanz K: **Physical activity and food environments: solutions to the obesity epidemic**. *Milbank Q* 2009, **87**(1):123-154.
125. Uijtdewilligen L, Nauta J, Singh AS, Van MW, Twisk JW, Van Der Horst K, Chinapaw MJ: **Determinants of physical activity and sedentary behaviour in young people: a review and quality synthesis of prospective studies**. *BrJSports Med* 2011, **45**(11):896-905.

126. Lynch J, Kaplan G: **Socioeconomic Position**. In: *Social Epidemiology.* edn. Edited by Berkman LF, Kawachi I. New York: Oxford University Press; 2000: 13-35.
127. Bradley RH, Corwyn RF: **Socioeconomic status and child development**. *AnnuRevPsychol* 2002, **53**:371-399.
128. Galobardes B, Lynch J, Smith GD: **Measuring socioeconomic position in health research**. *BrMedBull* 2007, **81-82**:21-37.
129. Roos E, Prattala R: **[Social inequalities in health related behaviours]**. In: *[The unfairness in health: socioeconomic differences of health and duration of life]*. edn. Edited by Rostila M, Toivanen S: Lieber; 2012: 201-220.
130. Rasmussen M, Krolner R, Klepp KI, Lytle L, Brug J, Bere E, Due P: **Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies**. *IntJBehavNutrPhysAct* 2006, **3**:22.
131. Pearson N, Biddle SJ, Gorely T: **Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review**. *Public Health Nutr* 2009, **12**(2):267-283.
132. Hoyos Cillero I, Jago R: **Systematic review of correlates of screen-viewing among young children**. *PrevMed* 2010, **51**(1):3-10.
133. Gorely T, Marshall SJ, Biddle SJ: **Couch kids: correlates of television viewing among youth**. *IntJBehavMed* 2004, **11**(3):152-163.
134. Blanchette L, Brug J: **Determinants of fruit and vegetable consumption among 6-12-year-old children and effective interventions to increase consumption**. *JHumNutrDiet* 2005, **18**(6):431-443.
135. Wind M, te Velde SJ, Brug J, Sandvik C, Klepp KI: **Direct and indirect association between environmental factors and fruit intake, mediation by psychosocial factors: the Pro Children study**. *Public Health Nutr* 2010, **13**(10A):1736-1745.
136. Bere E, Glomnes ES, te Velde SJ, Klepp KI: **Determinants of adolescents' soft drink consumption**. *Public Health Nutr* 2008, **11**(1):49-56.
137. Denney-Wilson E, Crawford D, Dobbins T, Hardy L, Okely AD: **Influences on consumption of soft drinks and fast foods in adolescents**. *Asia PacJClinNutr* 2009, **18**(3):447-452.
138. van Lippevelde W, te Velde SJ, Verloigne M, de Bourdeaudhuij I, Manios Y, Bere E, Jan N, Fernandez-Alvira JM, Chinapaw MJ, Bringolf-Isler B *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.
139. de Vet E, de Wit JB, Luszczynska A, Stok FM, Gaspar T, Pratt M, Wardle J, de Ridder DT: **Access to excess: how do adolescents deal with unhealthy foods in their environment?** *Eur J Public Health* 2013.
140. Berge JM: **A review of familial correlates of child and adolescent obesity: what has the 21st century taught us so far?** *IntJAdolescMedHealth* 2009, **21**(4):457-483.
141. Elfhag K, Tynelius P, Rasmussen F: **Family links of eating behaviour in normal weight and overweight children**. *IntJPediatrObes* 2010, **5**(6):491-500.
142. Perez-Pastor EM, Metcalf BS, Hosking J, Jeffery AN, Voss LD, Wilkin TJ: **Assortative weight gain in mother-daughter and father-son pairs: an emerging source of childhood obesity. Longitudinal study of trios (EarlyBird 43)**. *Int J Obes (Lond)* 2009, **33**(7):727-735.
143. Berge JM, Wall M, Bauer KW, Neumark-Sztainer D: **Parenting characteristics in the home environment and adolescent overweight: a latent class analysis**. *Obesity(SilverSpring)* 2010, **18**(4):818-825.

144. Pahkala K, Heinonen OJ, Lagstrom H, Hakala P, Sillanmaki L, Kaitosaari T, Viikari J, Aromaa M, Simell O: **Parental and childhood overweight in sedentary and active adolescents**. *ScandJMedSciSports* 2010, **20**(1):74-82.
145. Wouters EJ, Larsen JK, Kremers SP, Dagnelie PC, Geenen R: **Peer influence on snacking behavior in adolescence**. *Appetite* 2010, **55**(1):11-17.
146. Lien N, Bjelland M, Bergh IH, Grydeland M, Anderssen SA, Ommundsen Y, Andersen LF, Henriksen HB, Randby JS, Klepp KI: **Design of a 20-month comprehensive, multicomponent school-based randomised trial to promote healthy weight development among 11-13 year olds: The HEalth In Adolescents study**. *ScandJPublic Health* 2010, **38**(5 Suppl):38-51.
147. Bjelland M, Lien N, Bergh IH, Grydeland M, Anderssen SA, Klepp KI, Ommundsen Y, Andersen LF: **Overweight and waist circumference among Norwegian 11-year-olds and associations with reported parental overweight and waist circumference: The HEIA study**. *ScandJPublic Health* 2010, **38**(5 Suppl):19-27.
148. Bere E, Klepp KI: **Changes in accessibility and preferences predict children's future fruit and vegetable intake**. *IntJBehavNutrPhysAct* 2005, **2**:15.
149. Haraldsdottir J, Thorsdottir I, de Almeida MD, Maes L, Perez RC, Elmadfa I, Frost AL: **Validity and reproducibility of a precoded questionnaire to assess fruit and vegetable intake in European 11- to 12-year-old schoolchildren**. *AnnNutrMetab* 2005, **49**(4):221-227.
150. Lillegaard IT, Overby NC, Andersen LF: **Evaluation of a short food frequency questionnaire used among Norwegian children**. *Food NutrRes* 2012, **56**.
151. Page AS, Cooper AR, Griew P, Jago R: **Children's screen viewing is related to psychological difficulties irrespective of physical activity**. *Pediatrics* 2010, **126**(5):e1011-1017.
152. Torsheim T, Eriksson L, Schnohr CW, Hansen F, Bjarnason T, Valimaa R: **Screen-based activities and physical complaints among adolescents from the Nordic countries**. *BMC public health* 2010, **10**:324.
153. Bere E, Klepp KI: **Correlates of fruit and vegetable intake among Norwegian schoolchildren: parental and self-reports**. *Public Health Nutr* 2004, **7**(8):991-998.
154. Fulkerson JA, Nelson MC, Lytle L, Moe S, Heitzler C, Pasch KE: **The validation of a home food inventory**. *IntJBehavNutrPhysAct* 2008, **5**:55.
155. Hardy LL, Baur LA, Garnett SP, Crawford D, Campbell KJ, Shrewsbury VA, Cowell CT, Salmon J: **Family and home correlates of television viewing in 12-13 year old adolescents: the Nepean Study**. *IntJBehavNutrPhysAct* 2006, **3**:24.
156. Heck RH, Thomas SL, Tabata LN: **Multilevel and Longitudinal Modeling with IBM SPSS**. New York: Routledge; 2010.
157. Tabachnick GG, Fidell LS: **Experimental Designs using ANOVA**. Belmont: CA: Duxbury; 2007.
158. Gebremariam MK, Andersen LF, Bjelland M, Klepp KI, Totland TH, Bergh IH, Lien N: **Does the school food environment influence the dietary behaviours of Norwegian 11-year-olds? The HEIA study**. *ScandJPublic Health* 2012, **40**(5):491-497.
159. Gebremariam MK, Totland TH, Andersen LF, Bergh IH, Bjelland M, Grydeland M, Ommundsen Y, Lien N: **Stability and change in screen-based sedentary behaviours and associated factors among Norwegian children in the transition between childhood and adolescence**. *BMCPublic Health* 2012, **12**:104.
160. Kelder SH, Perry CL, Klepp KI, Lytle LL: **Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors**. *AmJPublic Health* 1994, **84**(7):1121-1126.

161. Fleiss JL, Cohen J: **The equivalence of weighted kappa and the intraclass correlation coefficient as measures of reliability**. *Educ Psychol Meas* 1973, **33**:7.
162. Baron RM, Kenny DA: **The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations**. *JPersSocPsychol* 1986, **51**(6):1173-1182.
163. Preacher KJ, Hayes AF: **Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models**. *BehavResMethods* 2008, **40**(3):879-891.
164. Fritz MS, Mackinnon DP: **Required sample size to detect the mediated effect**. *PsycholSci* 2007, **18**(3):233-239.
165. Bjelland M: **Obesity prevention targeting Norwegian adolescents: Prevalence rates, determinants and intervention effects by gender, parental education and parent-child associations**. *PhD Thesis.* University of Oslo; 2011.
166. Livingstone MB, Robson PJ: **Measurement of dietary intake in children**. *Proc Nutr Soc* 2000, **59**(2):279-293.
167. Jago R, Baranowski T, Baranowski JC, Cullen KW, Thompson DI: **Social desirability is associated with some physical activity, psychosocial variables and sedentary behavior but not self-reported physical activity among adolescent males**. *Health Educ Res* 2007, **22**(3):438-449.
168. Kolodziejczyk JK, Merchant G, Norman GJ: **Reliability and validity of child/adolescent food frequency questionnaires that assess foods and/or food groups**. *J Pediatr Gastroenterol Nutr* 2012, **55**(1):4-13.
169. Lubans DR, Hesketh K, Cliff DP, Barnett LM, Salmon J, Dollman J, Morgan PJ, Hills AP, Hardy LL: **A systematic review of the validity and reliability of sedentary behaviour measures used with children and adolescents**. *Obes Rev* 2011, **12**(10):781-799.
170. Vereecken CA, Maes L: **Comparison of a computer-administered and paper-and-pencil-administered questionnaire on health and lifestyle behaviors**. *J Adolesc Health* 2006, **38**(4):426-432.
171. Elstad JI: **[Education and inequalities in health: Research questions and findings]**. In. Oslo: Norwegian Directorate of Health; 2008.
172. Jago R, Baranowski T, Baranowski JC: **Fruit and vegetable availability: a micro environmental mediating variable?** *Public Health Nutr* 2007, **10**(7):681-689.
173. Cullen KW, Baranowski T, Owens E, Marsh T, Rittenberry L, de MC: **Availability, accessibility, and preferences for fruit, 100% fruit juice, and vegetables influence children's dietary behavior**. *Health EducBehav* 2003, **30**(5):615-626.
174. Bryant M, Stevens J: **Measurement of food availability in the home**. *Nutr Rev* 2006, **64**(2 Pt 1):67-76.
175. DeVellis RF: **Scale development: Theory and Applications**, vol. 26, 2nd edn. Thousand Oaks: SAGE Publications; 2003.
176. Streiner DL, Norman GR: **Health measurement scales: a practical guide to their development and use**, 4th edn. New York: Oxford University Press; 2008.
177. Twisk JWR: **Applied Longitudianl Data Analysis for Epidemiology - A Practical Guide**, vol. 4th. New York: Cambridge; 2007.
178. Cohen J: **Weighted kappa: nominal scale agreement with provision for scaled disagreement or partial credit**. *PsycholBull* 1968, **70**(4):213-220.
179. Fitzmaurice G: **Regression to the mean**. *Nutrition* 2000, **16**(1):80-81.
180. MacKinnon DP: **Analysis of mediating variables in prevention and intervention research**. *NIDA ResMonogr* 1994, **139**:127-153.

181. Cerin E, Mackinnon DP: **A commentary on current practice in mediating variable analyses in behavioural nutrition and physical activity**. *Public Health Nutr* 2008:1-7.
182. Shrout PE, Bolger N: **Mediation in experimental and nonexperimental studies: new procedures and recommendations**. *PsycholMethods* 2002, **7**(4):422-445.
183. MacKinnon DP, Krull JL, Lockwood CM: **Equivalence of the mediation, confounding and suppression effect**. *Prevention science : the official journal of the Society for Prevention Research* 2000, **1**(4):173-181.
184. MacKinnon DP, Lockwood CM, Hoffman JM, West SG, Sheets V: **A comparison of methods to test mediation and other intervening variable effects**. *PsycholMethods* 2002, **7**(1):83-104.
185. 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**. *IntJBehavNutrPhysAct* 2009, **6**:91.
186. 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**. *PrevMed* 2011, **53**(4-5):268-270.
187. Vejrup K, Lien N, Klepp KI, Bere E: **Consumption of vegetables at dinner in a cohort of Norwegian adolescents**. *Appetite* 2008, **51**(1):90-96.
188. Li J, Wang Y: **Tracking of dietary intake patterns is associated with baseline characteristics of urban low-income African-American adolescents**. *JNutr* 2008, **138**(1):94-100.
189. Ezendam NP, Evans AE, Stigler MH, Brug J, Oenema A: **Cognitive and home environmental predictors of change in sugar-sweetened beverage consumption among adolescents**. *BrJNutr* 2010, **103**(5):768-774.
190. Hanson MD, Chen E: **Socioeconomic status and health behaviors in adolescence: a review of the literature**. *JBehavMed* 2007, **30**(3):263-285.
191. Halldorsson M, Kunst AE, Kohler L, Mackenbach JP: **Socioeconomic inequalities in the health of children and adolescents: A comarative study of the five Nordic countries**. *EurJPublic Health* 2000, **10**(4):281-288.
192. Schmitz KH, Lytle LA, Phillips GA, Murray DM, Birnbaum AS, Kubik MY: **Psychosocial correlates of physical activity and sedentary leisure habits in young adolescents: the Teens Eating for Energy and Nutrition at School study**. *PrevMed* 2002, **34**(2):266-278.
193. Lee SJ, Bartolic S, Vandewater EA: **Predicting children's media use in the USA: differences in cross-sectional and longitudinal analysis**. *BrJDevPsychol* 2009, **27**(Pt 1):123-143.
194. Kristiansen H, Juliusson PB, Eide GE, Roelants M, Bjerknes R: **TV viewing and obesity among Norwegian children: the importance of parental education**. *Acta Paediatr* 2013, **102**(2):199-205.
195. 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.
196. Hilsen M, te Velde SJ, Bere E, Brug J: **Predictors and mediators of differences in soft drinks consumption according to gender and plans of further education among Norwegian secondary-school children**. *Public Health Nutr* 2011:1-7.
197. Tak NI, te Velde SJ, Oenema A, Van Der Horst K, Timperio A, Crawford D, Brug J: **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):503-510.

198. Hesketh K, Ball K, Crawford D, Campbell K, Salmon J: **Mediators of the relationship between maternal education and children's TV viewing**. *AmJPrevMed* 2007, **33**(1):41-47.
199. Henricson C, Roker D: **Support for the parents of adolescents: a review**. *J Adolesc* 2000, **23**(6):763-783.
200. Bjelland M, Lien N, Grydeland M, Bergh IH, Anderssen SA, Ommundsen Y, Klepp KI, Andersen LF: **Intakes and perceived home availability of sugar-sweetened beverages, fruit and vegetables as reported by mothers, fathers and adolescents in the HEIA (HEalth In Adolescents) study**. *Public Health Nutr* 2011, **14**(12):2156-2165.
201. Jago R, Stamatakis E, Gama A, Carvalhal IM, Nogueira H, Rosado V, Padez C: **Parent and child screen-viewing time and home media environment**. *AmJPrevMed* 2012, **43**(2):150-158.