

Television and food in the lives of young children



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## Abstract

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Several mechanisms have been proposed behind the associations between screens and overweight including sedentary behaviour, eating while viewing, and exposure to commercials. Aspects of this association as underlying social factors and the possible confounding factors of social norms in the family that can affect children's lifestyle have received less attention. TV commercials for food and beverages have been extensively studied and it is important to study the appearance of food in children's TV programmes in a similar way. The general aim of this thesis is to examine the associations between young children's screen habits, food habits and anthropometry as well as to analyse food and beverages in children's television programmes in public service television in Sweden. Data from the European research project Identification and prevention of dietary and lifestyle-induced health effects in children and infants (IDEFICS) has been used in Papers I-III and 25 hours of children's TV programmes have been analysed for Paper IV.

The main findings indicate that children's TV viewing and total screen time was found to be associated with their increased sweet drink consumption, BMI and waist to height ratio, according to cross-sectional and longitudinal analyses. The association between TV viewing and sweetened beverage consumption was found to be independent of parental norms regarding sweetened beverages. Exposure to commercial TV was associated with consuming sweetened beverages more frequently independently of TV viewing time. One in five foods appearing in the sample of children's TV programmes was for high-calorie and low-nutrient foods, often appearing with children. The results indicate that it is possible to affect children's food habits by influencing their TV habits, and that public service television has the potential to improve the way food and eating are depicted in children's TV programmes.

## Swedish summary

Tidigare forskning har visat att TV- och datoranvändande kan öka sannolikheten för övervikt och sämre matvanor bland barn. Olika mekanismer har föreslagits ligga bakom dessa samband: Stillasittande, ätande framför TV:n och effekt av TV-reklam. Vissa aspekter av sambanden har fått mindre uppmärksamhet än andra, t ex att det kan vara sociala normer i familjen som förklarar dessa samband. Kunskap saknas också om matbudskap i barnprogram på TV.

Det övergripande syftet med denna avhandling är att undersöka sambanden mellan små barns skärmvanor, matvanor och viktstatus samt att analysera hur mat och dryck framställs i barnprogram i public service TV i Sverige.

Data från det europeiska forskningsprojektet IDEFICS (Identification and prevention of dietary and lifestyle-induced health effects in children and infants) används i studierna I-III. IDEFICS är en prospektiv studie om 2-9 åringars matvanor och livsstil. Åtta europeiska länder deltog under åren 2007-2010: Sverige, Estland, Tyskland, Belgien, Ungern, Italien, Spanien och Cypern.

Studie IV bygger på barnprogram i Sveriges television. Studieobjektet för delstudie IV var det populäraste barnprogrammet i Sverige (Bolibompa). Utsänt material under fem månader (December 2011-April 2012), ca 25 timmar, analyserades. All förekomst av mat och dryck i materialet kategoriserades. Det gjorde även den miljö och kontext i vilka maten visades eller pratades om, exempelvis om maten presenterades med ett barn eller vuxen. Två grupper av livsmedel, intressanta ur hälsoperspektiv, analyserades med avseende på kontext: Frukt och grönt samt energirik och näringsfattig mat (HCLN: high-calorie and low-nutrient foods).

Syftet med studie I var att undersöka sambandet mellan barns TV- och datoranvändande och deras konsumtion av söta drycker, med hänsyn till föräldranormer om läskkonsumtion (Sverige). Studien visade att samband fanns mellan barnens TV-tittande, såväl tid framför TV som exponering för reklam, och barnens konsumtion av söta drycker. Sambandet var oberoende av föräldrars normer angående söta drycker (hur ofta de själva konsumerade söta drycker och vad de tyckte om barnens konsumtion). Barn vars föräldrar var mer tillåtande angående TV-reklam löpte dubbelt så stor risk att konsumera söta drycker varje vecka.

Syftet med studie II var att undersöka samband mellan små barns TV- och skärmtittande och ändringar i konsumtion av sockersötade drycker och ändringar i BMI och midja-längd kvot (8 europeiska länder). Studie II visade att samband fanns mellan barnens TV-tittande och övervikt samt sannolikhet för att öka i BMI och midja-längd kvot. Inget samband fanns mellan konsumtion av söta drycker och övervikt.

Studie III syftade till att undersöka om små barns TV vanor (titta mer än 60 minuter per dag, ha TV på sovrummet, titta på TV under måltider) var kopplade till viktstatus och indikatorer för kostmönster som kännetecknas av feta och sockerrika livsmedel (8 europeiska länder). Studien visade att samband fanns mellan barnens TV-vanor och övervikt samt benägenhet för fett- och sockerrik mat.

Studie IV syftade till att undersöka hur mat och dryck framställs i Sveriges televisions barnprogram genom att analysera frekvens och typ av livsmedel, i vilken sammanhang mer och mindre hälsosam mat framställs, samt identifiera budskap om smak och hälsa. Studien visade att ett av fem livsmedel som visades i barnprogrammen var HCLN-mat så som kakor, godis och glass. Denna typ av mat framställdes ofta aktivt och tillsammans med barn. Frukt och grönt visades ofta men å andra sidan främst i bakgrunden.

Avhandlingen kan bidra till kunskaper med betydelse för folkhälsa och public service TV. Genom att belysa hur mat framställs i barnprogram i svensk TV visar den att det finns potential till en mer hälsofrämjande ansats. Hälsosam mat var framträdande i de svenskproducerade delarna av barnprogrammen men i övriga delar var det även vanligt att sockerrik mat framhölls. Det innebär att det finns utrymme för att främja mer hälsosamma alternativ.

Avhandlingens resultat indikerar även att det kan vara möjligt att påverka barns matvanor via deras TV-vanor, eftersom föräldrars försök att begränsa sina barns exponering för TV-reklam visade sig vara förenat med lägre konsumtion av söta drycker hos barnen. Föräldrar och familj är viktiga för utveckling av hälsosamma matvanor hos barn men bär inte hela ansvaret. Sambandet mellan barns TV-tittande och deras konsumtion av söta drycker visade sig vara oberoende av föräldranormer angående söta drycker. Föräldrar har inte kontroll över det "fetmaframkallande samhället" som främjar konsumtion av energirik mat och stillasittande. Främjande av hälsosam vikt kräver åtgärder på olika nivåer.

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## List of original papers

I Olafsdottir S, Eiben G, Prell H, Hense S, Lissner L, Mårild S, Reisch L, Berg C. (2013). Young children's screen habits are associated with consumption of sweetened beverages independently of parental norms. *International Journal of Public Health*. doi: 10.1007/s00038-013-0473-2 Epub ahead of print 27 Apr 2013.

II Olafsdottir S, Berg C, Eiben G, Lanfer A, Reisch L, Ahrens W, Kourides Y, Molnar D, Moreno LA, Siani A, Veidebaum T, Lissner L. (2014). Young children's screen activities, sweet drink consumption and anthropometry: Results from a prospective European study. *European Journal of Clinical Nutrition* 68(2):223-228. doi: 10.1038/ejcn. Epub 20 Nov 2013.

III Lissner L, Lanfer A, Gwozdz W, Olafsdottir S, Eiben G, Moreno LA, Santaliestra-Pasias AM, Kovacs E, Barba G, Loit H-M, Kourides Y, Pala V, Pohlabein H, De Henauw S, Buchecker K, Ahrens W, Reisch L. (2012). Television habits in relation to overweight, diet and taste preferences in European children: the IDEFICS study. *European Journal of Epidemiology* 27(9):705-715. doi: 10.1007/s10654-012-9718-2 Epub 22 Aug 2012.

IV Olafsdottir S & Berg C. Food appearances in children's television programmes in Sweden. (Submitted for publication).

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## Abbreviations

AAP	American Academy of Pediatrics
ASB	Artificially sweetened beverages
BMI	Body mass index
CEHQ	Children eating habits questionnaire
CI	Confidence interval
EST	Ecological systems theory
FV	Fruits and vegetables
FFQ	Food frequency questionnaire
HCLN	High-calorie and low-nutrient foods
IDEFICS	Identification and prevention of dietary and lifestyle-induced health effects in children and infants
ISCED	International Standard Classification of Education
MVPA	Moderate to vigorous physical activity
OR	Odds ratio
PA	Physical activity
PBS	Public Broadcasting Service
SES	Socio-economic status
SB	Sweetened beverages
SSB	Sugar-sweetened beverages
SVT	Sveriges television
SVTB	Sveriges television Barnkanalen
TV	Television
WHO	World Health Organization
WHtR	Waist to height ratio



# Introduction

Food is abundant in Western societies and the marketing of food is ubiquitous. The promotion of fast food and sugary products shadows the promotion of healthy food. Establishing healthy habits in today's marketing environment is a challenge for parents of young children as the marketing of sweets and fast food is often aimed at children and their parents. Habits are established at a young age, and the importance of the preschool age has been stressed. This accounts for both food habits and screen habits. Healthy eating and limited sedentary behaviour are important for children's wellbeing and weight status. Many factors can influence this balance, of which screen use is one. This thesis focuses on aspects of this equation: food, weight status and screen use.

The research field of young children's food habits, weight status and screen use is large and complex. This thesis does not include every aspect of the field but touches upon several through two data sources: the European research project, Identification and prevention of dietary and lifestyle-induced health effects in children and infants (IDEFICS), and television (TV) content from public service television in Sweden. The data for this thesis was gathered from 2007 to 2012. During the most recent years, new screens such as tablets and smart phones have entered as a quite natural part of daily life in Western societies, not only for adults, but also for young children. Surveys now take infants' media use into account (Swedish Media Council, 2013) and Internet use has become an integral part of everyday life for families and children as young as three years old (Findahl, 2010). All of this information has not been captured in the data where the focus is on TV viewing, which still seems to be going strong among the youngest, and for that matter, among the total population in Sweden, as 87% of the total viewing time is devoted to traditional TV (Findahl, 2013). The fact that Sweden has a long tradition of children's TV programming, is one of the reasons for the interest in examining the content of the children's programmes broadcast in public service TV in Sweden. Two papers focus on Sweden (Papers I and IV) and two papers (Papers II and III) focus on eight European countries, of which Sweden is one. The first three papers concern the associations between young children's TV viewing and food habits or weight status and the fourth paper

concentrates on food and beverage appearances in children's TV programmes in Sweden.

This introduction is structured as follows: An ecological model of predictors of childhood overweight (Davison & Birch, 2001) is presented in Figure 1, followed by an overview of some previous research in this large research field, structured by the circles of the ecological model, i.e. child characteristics, family characteristics and societal characteristics. Finally, some views on television in time are presented.

## Ecological model

The determinants of young children's food habits and weight status are multiple and the pathways complicated, as the extensive body of research has shown. Figure 1 describes the application of Bronfenbrenner's Ecological Systems Theory (EST) (Bronfenbrenner, 1986, 1992) to predictors of childhood overweight and obesity (Davison & Birch, 2001). Davison and Birch stressed the importance of developing a model for studying the interaction between children's dietary and activity patterns, the parenting practices that shape these, and the environment in which "parenting takes place" (Davison & Birch, 2001). EST highlights the importance of considering the context in which a person exists (Davison & Birch, 2001). The context is not only the immediate context in which a person lives, i.e. the family, but also, as in case of a child, it is, for example, the school, which in turn is embedded in a larger social context; the community and the society in general.

## INTRODUCTION

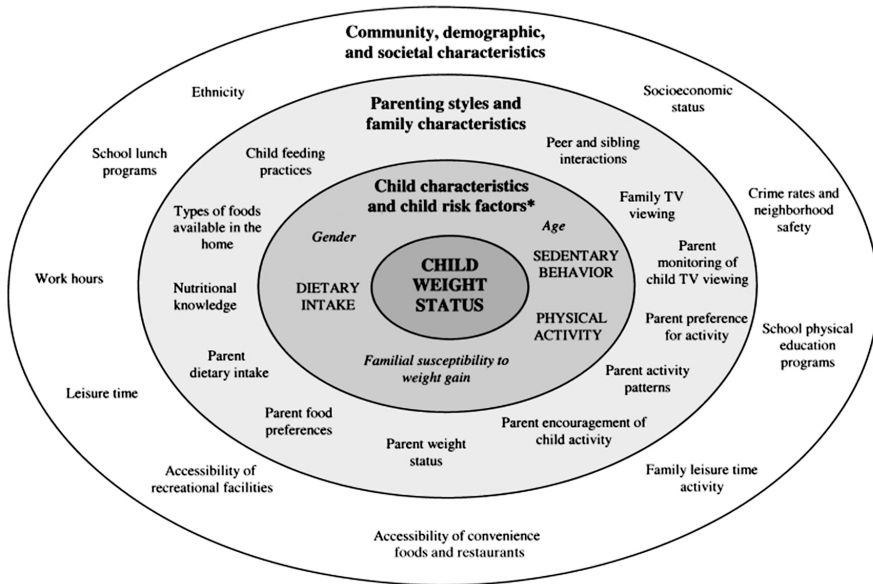


Figure 1. Ecological model of predictors of childhood overweight (Davison & Birch, 2001).

Bronfenbrenner explains the ecology of human development: “The ecology of human development is the scientific study of the progressive, mutual accommodation, throughout the life course, between an active, growing human being, and the changing properties of the immediate settings in which the developing person lives, as this process is affected by the relations between these settings, and by the larger contexts in which the settings are embedded.” (Bronfenbrenner, 1992) (pp. 188). According to EST, development or changes in individual characteristics occur as a result of interactions within and among these contexts. Bronfenbrenner formulated a hierarchy of systems at four levels for the larger contexts mentioned: micro-, meso-, exo-, and macrosystems (Bronfenbrenner, 1992) (pp. 226). The microsystem is a pattern of activities, roles, and interpersonal relations experienced by a developing person (e.g. with parents). The mesosystem is a system of microsystems comprising the linkages and processes taking place between two or more settings containing the developing person (e.g. the relations between home and school). The exosystem includes the processes taking place between two or more settings, of which one does not ordinarily contain the developing person, but can influence her or him (e.g. the relation

between the home and the parent's work place). Finally, the macrosystem consists of the overarching pattern of micro-, meso-, and exosystem characteristic of a given culture, subculture, or other broader social context. The patterns of belief and behaviour characterising the macrosystem are passed on from one generation to the next through processes of socialization carried out by various institutions of the culture and structures of government (Bronfenbrenner, 1992) (pp. 226-229).

The aim of Davison and Birch's review was to highlight the necessity of addressing characteristics of the child and the contexts in which the child is embedded in order to understand the process of childhood overweight development (Davison & Birch, 2001). The child behaviours associated with the development of overweight interact with other contextual characteristics including parenting styles and family characteristics, which in turn are determined by community and social characteristics.

## Child characteristics: The energy balance

Child characteristics that are important for the child's weight status, as depicted in Figure 1 represent both sides of the energy balance: energy intake and energy expenditure (dietary intake vs. sedentary behaviour, physical activity). Simply put, an imbalance in energy intake and energy expenditure can create under- or overweight conditions in individuals. It has been proposed that dietary fats and sugars affect the health in negative ways and contribute to the obesity epidemic (Melanson, Astrup, & Donahoo, 2009; van Baak & Astrup, 2009).

### **Sweetened beverages**

Regarding energy intake, the main focus in this thesis is on sweetened beverages. Sugar consumption has increased dramatically in the world during the last decades. Sugar-sweetened beverages (SSBs) comprise a large part of that increase. In addition, the consumption of artificially sweetened beverages (ASB) has also increased, in the form of diet soft drinks (Popkin, 2010). Children's increased consumption of SSB is an issue that needs to be addressed from a public health perspective as the drinks can entail a positive energy balance with their low satiety value (Mourao, Bressan, Campbell, & Mattes, 2007; Popkin, 2010) and considerable contribution to sugar and energy intake in children (Swedish National Food Administration, 2007).



Sugar-sweetened beverages are nutrient poor, marketed extensively to youth (Kelly et al., 2010) and highly consumed by them (Duffey et al., 2012). Recent trends show decrease in children's SSB consumption in the USA (Kit, Fakhouri, Park, Nielsen, & Ogden, 2013). According to an international survey (World Health Organization, 2012b) to 11 year olds in 39 countries, 18% on average consume soft drinks daily, with the lowest consumption in the Nordic countries (2% of girls and 5% of boys in Sweden).

The parallel increase in the prevalence of childhood obesity and consumption of SSBs has led to suggestions that they may be causally related. Some studies have reported prospective positive relationships but not all. This could be due to differences in the studies in measures or confounders, such as physical activity (Rennie, Johnson, & Jebb, 2005). A systematic review and meta-analysis of prospective studies and randomised controlled trials resulted in the conclusion that they provided evidence that SSB consumption promotes weight gain in both children and adults (Malik, Pan, Willett, & Hu, 2013).

Consumption of those energy rich and nutrient poor beverages has been linked to an increased risk of developing type 2 diabetes in adults (Sonestedt, Överby, Laaksonen, & Birgisdottir, 2012; Vartanian, Schwartz, & Brownell, 2007). The recent systematic review prepared as a part of the fifth Nordic Nutrition Recommendations (Sonestedt et al., 2012), drew the conclusion from the included prospective cohort studies from 2000 to 2011 that SSBs probably increase the risk of type 2 diabetes, and this association might be mediated by obesity as suggested by some of the reviewed studies. Furthermore, according to the reviewed studies, the risk of type 2 diabetes increased at a consumption of two or more servings of SSBs per week. The studies reviewed were based on adult consumption, and it is thus interesting to speculate on the effects for young children. Decreasing children's SSB consumption has been identified in recent years as one of the most important factors in preventing childhood obesity and promoting health (Johnson, Kremer, Swinburn, & de Silva-Sanigorski, 2012; Ludwig, Peterson, & Gortmaker, 2001; Moreno & Rodríguez, 2007).

## **Television viewing**

TV viewing is the most prevalent sedentary behaviour along with computer work and sitting while socialising. Sedentary behaviour is defined as a slight increase in energy expenditure above the resting metabolic rate but below the

expenditure seen with light-intensity physical activity (Pate, Mitchell, Byun, & Dowda, 2011; Pate, O'Neill, & Lobelo, 2008). Sedentary behaviour and physical activity are increasingly seen as independent constructs, as an individual can still meet recommended levels of physical activity even if he or she spends a large proportion of time in sedentary behaviour. The focus in this thesis is on television viewing and screen use and not other sedentary behaviours or physical activity.

TV has become a ubiquitous part of daily life for both children and adults. Evidence suggests that it has contributed to the obesity epidemic. TV viewing habits can adversely influence both present and future dietary intake and body weight (Boulos, Kuross Vikre, Oppenheimer, Chang, & Kanarek, 2012). Several mechanisms through which TV viewing could increase the likelihood of developing overweight have been suggested: increased time spent in sedentary behaviour, greater exposure to marketing of energy dense foods in TV commercials, and/or eating in front of the TV (B. Swinburn & Shelly, 2008). TV viewing has been linked to increased body mass index (BMI) (Giammattei, Blix, Marshak, Wollitzer, & Pettitt, 2003; Hancox, Milne, & Poulton, 2004) and childhood obesity (Epstein et al., 2008; Ludwig & Gortmaker, 2004) but the pathways remain poorly understood (Carson & Janssen, 2012).

Previous studies have indicated that the influence of TV on weight is through dietary intake rather than physical inactivity (Cleland, Schmidt, Dwyer, & Venn, 2008); other studies have shown that sedentary behaviour in terms of lack of physical activity is one of the explanatory factors (Monasta et al., 2010). The pathways between TV viewing and overweight remain complicated and are multidimensional. Study results concerning the associations among all three factors, i.e. TV viewing, sweetened beverage consumption and childhood obesity, seem somewhat inconclusive. Carson and Janssen (Carson & Janssen, 2012) found a positive association between TV viewing and BMI, but dietary intake was not a mediator of this relationship. An Australian study (Clifton, Chan, Moss, Miller, & Cobiac, 2011) found that TV viewing was positively related to soft drink consumption, but the study provided little support to the notion that excessive consumption of sweetened beverages causes overweight in children. The sedentary nature of TV viewing is another mechanism suggested behind the association between TV viewing and overweight (B. Swinburn & Shelly, 2008). The design of studies reaching the conclusion that excess TV viewing influences

overweight is a key in assessing them. Cross-sectional designed studies leave the readers with the issue of reverse causality: Does the weight of obese children prohibit more active play and enhance more TV viewing or is it the sedentary behaviour and/or changed food habits when watching TV that predict weight gain? Both may be true. Multiple pathways in the association between TV viewing and overweight need to be considered (Boulos et al., 2012).

Several studies have found a relationship between time spent viewing TV and dietary habits such as a higher intake of sugary and fast foods as well as a lower intake of fruits and vegetables (Boynton-Jarrett et al., 2003; Giammattei et al., 2003; McGowan, Croker, Wardle, & Cooke, 2012; Miller, Taveras, Rifas-Shiman, & Gillman, 2008). Longitudinal associations between TV viewing and poor eating habits have also been observed (Barr-Anderson, Larson, Nelson, Neumark-Sztainer, & Story, 2009; Hare-Bruun et al., 2011; Pearson, Ball, & Crawford, 2011). Studies on the specific association between TV viewing and soft drink consumption have found a positive association (Boynton-Jarrett et al., 2003; Feldman, Eisenberg, Neumark-Sztainer, & Story, 2007; Giammattei et al., 2003; McGowan et al., 2012; Miller et al., 2008; Péneau et al., 2009; Van Strien, van Niekerk, & Ouwens, 2009). Not all studies have found an association between TV viewing and eating habits. Francis and Birch (Francis & Birch, 2006) found that TV viewing could either increase or decrease preschool children's food intake, and caregivers should be advised against providing opportunities for children to eat during TV viewing.

Kremers and colleagues (Kremers, van der Horst, & Brug, 2007) found an association between screen-viewing behaviour and consumption of sugar-sweetened beverages among adolescents. They used habit theory, which includes the notion that when habits are formed, subsequent behaviour is automatically triggered by specific environmental cues that normally precede the action. According to this, they suggested that when engagement in screen-viewing behaviour has been repeatedly accompanied by consumption of sugar-sweetened beverages, screen viewing might thus become an automatic cue to drink these beverages.

According to reviews, the relationship between TV viewing and food behaviour could be explained by greater exposure to marketing of energy dense foods (Cairns, Angus, & Hastings, 2009) as well as eating in front of the TV (Jordan & Robinson, 2008; B. Swinburn & Shelly, 2008). An updated review of the extent and effects of food promotion to children was prepared for WHO (Cairns et al., 2009), concluding that the evidence for links to food

behaviours and diet-related health outcomes are modest but likely to be causal. It has been proposed that food and taste preferences may in part be determined by messages seen on TV (Harris & Bargh, 2009; Harris, Bargh, & Brownell, 2009).

The effects of food advertisements have been studied to some extent and have been found to influence unhealthy food habits (Boyland & Halford, 2013; Boyland, Harrold, Kirkham, & Halford, 2012). TV advertisements for food have been content-analysed in an international study (Kelly et al., 2010), which found that the majority of advertised foods were for unhealthy foods. In addition to advertisements, the viewers can watch a variety of films and programmes intended for all kinds of interests. Children's programmes have been content-analysed to some extent, foremost in the USA, with the conclusions that unhealthy foods appear to a greater extent than healthy foods in programmes aimed at one to four year olds within the US public service (PBS) channels (Radnitz et al., 2008). Findings from another US study on how food and drink are portrayed in commercial TV series indicate that foods in general were more commonly offered and consumed on children's shows than on adult-oriented shows (Greenberg, Rosaen, Worell, Salmon, & Volkman, 2009).

It has become more important than ever to study the importance of the non-advertising effects of screen time, as recent technology allows the viewers to decide when and where they watch TV and gives them the option of skipping advertisements. The authors of a recent review on the non-advertising effects of screen-based sedentary activities on dietary intake (Marsh, Mhurchu, & Maddison, 2013) conclude that even in the absence of advertising, screen-based behaviours can increase energy consumption in children (as well as adolescents, and young adults). A study on the characteristics of screen media and measured BMI in 13-15 year olds used a time-use diary for TV, computers and video games where the adolescents responded to signals reporting activities to which they were paying primary, secondary or tertiary attention (Bickham, Blood, Walls, Shrier, & Rich, 2013). The conclusions were that higher proportions of primary attention to TV were positively associated with higher BMI, but the time spent watching TV was unrelated to BMI. Thus, content of TV or video games, or at least the adolescents' attention towards the content, seems to matter.

Another important aspect of TV viewing habits is sleep. Children younger than the age of three are awake for about 10 to 12 hours per day, and it has been suggested in an American study that as much as 30% of their waking

hours might be spent in front of a monitor (Christakis & Zimmerman, 2009). Screen use increases and sleep decreases with age. A longitudinal study on the association between lack of sleep and obesity for 5-9 year olds concluded that increased TV viewing might be one mechanism underlying this relationship (Magee, Caputi, & Iverson, 2013). Compared with decreased sleep, increased sleep duration in school-age children resulted in lower reported food intake and lower weight, according to a recent experimental study (Hart et al., 2013). Access to, and night-time use of electronic entertainment and communication devices have been associated with shortened sleep duration, excess body weight, poorer diet quality, and lower physical activity levels in children (Chahal, Fung, Kuhle, & Veugelers, 2012). A meta-analysis on studies on healthy adults found that TV watching, alcohol intake, and sleep deprivation are not merely correlated with obesity but likely contribute to it by encouraging excessive eating (Chapman, Benedict, Brooks, & Schiöth, 2012).

Boulos and colleagues (Boulos et al., 2012) have summarised television's proposed contribution to the obesity epidemic in a review and identify much of what has been covered in this section. In addition, the indirect effects identified by the reviewed studies are the extensive and expansive use of product placements in TV shows, the large increase in programming that features food preparation, consumption and weight loss as entertainment, and portrayal of an idealised body image, which can lead to discrimination and stereotyping.

## Family characteristics

### **Dietary intake**

Parents are important in young children's lives. The circle "parenting styles and family characteristics" in the ecological model (Figure 1) (Davison & Birch, 2001), includes characteristics such as child feeding practices, types of foods available in the home, parent dietary intake and parent food preferences.

According to longitudinal data from the Norwegian Mother and Child Cohort Study (Bjelland et al., 2013), promotion of healthy dietary behaviours at an early age is important to prevent unfavourable dietary behaviours later in childhood. Results from a cross-sectional study on adolescents (van der Horst et al., 2007) confirmed that parenting practices and adolescent's SSB consumption were associated. The association was stronger among adolescents who perceived their parents to be moderately strict and highly

involved. Previous research has suggested a positive association between parents as role models and children's intake of vegetables (Campbell, Crawford, & Ball, 2006). A study on parental food controlling practices concluded that low perceived parental restriction regarding food might be a sign of what was called an obesogenic home environment, characterised by high snacking, low fruit consumption and high use of screen media (Van Strien et al., 2009). Peers and siblings can also be of importance. Having older siblings has been significantly associated with a frequent intake of sugar-rich foods (Brekke, van Odijk, & Ludvigsson, 2007). Older siblings can be role models for the younger ones and might, for example, also be allowed more TV, which could make it harder for parents to set limits for the younger siblings.

Although studies have demonstrated that TV viewing can relate to overweight and poor eating habits, this does not prove causality. There might be a confounding factor in the association, namely social norms in the family regarding dietary consumption. To illustrate, parents who tend to limit TV time might also be disposed to limit consumption of certain foods. In other words, dietary intake might be a result of parental norms on dietary consumption, rather than a consequence of TV exposure. Parental norms on dietary consumption can be described as parents influencing by acting as role models (descriptive norms) as well as approving or disapproving certain consumption (injunctive norms), according to Cialdini and Trost's definition (Cialdini & Trost, 1998) (pp. 155-157). When it comes to the choice of breakfast foods for 11 year olds, a Swedish study found that descriptive norms were distinct from injunctive norms, and of greater importance (Berg, Jonsson, & Conner, 2000).

Both types of norms promote behaviours by providing information about what is adaptive behaviour in a given situation. Descriptive norms provide information about what is done, and injunctive norms indicate what ought to be done. It has been argued that when people perceive social sanctions for not complying with certain behaviour (injunctive norm), they are more likely to conform if they also perceive that the behaviour is widespread among their peers (descriptive norm). Thus, strong injunctive norms were not enough to influence behaviour but the greatest compliance was observed when descriptive and injunctive norms were both high (Knight Lapinski & Rimal, 2005).

## Television viewing

Also within the ecological model (Figure 1), are various family characteristics regarding screens that can be of importance in predicting childhood overweight, e.g., family TV viewing and parent monitoring of child TV viewing.

Excessive screen exposure seems to be occurring among infants, at least in the US, according to recent research (DeLoache & Chiong, 2009), where it is described that many infants have TV sets in their bedrooms in addition to being in the family room while parents watch their own TV shows. “Video screens are already built into the backs of the front seats of family automobiles so infants and children can watch videos from their car seats, and video screens have even begun to appear on shopping carts to keep infants and toddlers occupied while their parents shop.” Furthermore, video products are being marketed for infants and bought by parents with the expectation that their infants will learn from them (DeLoache & Chiong, 2009).

Most children watch some TV, but parents control the frequency and quantity, at least at a preschool age. When the children grow older, they can watch at a friend’s house and to a greater extent control the content on the TV, a computer, a tablet or a smart phone. Research has stressed the importance of the preschool age range for the development of energy balance-related behaviours, e.g. physical activity and dietary behaviours (Jackson, Djafarian, Stewart, & Speakman, 2009). Early viewing habits predict future ones. The more TV children watch before the age of three, the more likely they are to protest having the TV turned off at school age (Christakis & Zimmerman, 2009).

Parents can monitor their children’s TV viewing, to some extent, to minimise the factors identified in connection to screen exposure not being beneficial to health. For example, parents should avoid having a TV in the child’s bedroom according to a new cross-sectional study within IDEFICS (Santaliestra-Pasías et al., 2013), as availability of a TV in personal space increased the risk of excess total screen time for the children. Limiting opportunities for watching TV decreases the TV viewing as found in an Australian study (Van Zutphen, Bell, Kremer, & Swinburn, 2007). Children living in a family with rules governing TV viewing time, who never watched TV during dinner, had only one TV in the household or had no TV in their bedroom, watched significantly less TV than their counterparts.

## Societal characteristics

The outer circle of community, demographic and societal characteristics in the ecological model in Figure 1 is of importance for this thesis, even though none of the characteristics named in the model are central to it. The obesogenic environment is a term used to describe an environment that promotes high-energy intake and sedentary behaviours, or according to the authors of the concept “the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations” (B. Swinburn, Egger, & Raza, 1999). More specifically, this type of environment provides opportunities to minimise physical activity for transportation and during everyday life, as well as allow high availability and accessibility of palatable energy-dense foods, and strong social norms and social pressure to eat such foods (Brug, Kremers, van Lenthe, Ball, & Crawford, 2008); in other words, any characteristic that acts as a barrier to maintaining a healthy weight (Kirk, Penney, & McHugh, 2010).

The term “obesogenic environment” applies to all the circles in Figure 1, including the circles on the community, demographic and societal characteristics, such as family leisure time activity and accessibility of convenience foods and restaurants. It could be argued that further societal factors are missing in the ecological model. For example the food supply and marketing environments that promote high energy intake, as according to a framework to categorise obesity determinants and solutions in Lancet’s obesity series by Swinburn and colleagues (B. A. Swinburn et al., 2011).

Childhood obesity is a public health concern. It has a complex aetiology and can have long-term effects throughout adulthood, including premature mortality and morbidity (Reilly & Kelly, 2011). The prevalence of overweight and obesity has increased over the past three decades, and even though the increase seems to have ceased in developed countries (Wabitsch, Moss, & Kromeyer-Hauschild, 2014), 170 million children worldwide under the age of 18, which includes over 40 million preschool children, are now classified as overweight according to WHO (World Health Organization, 2012a). The consequences for health can be serious, with increased risk for developing cardiovascular disease and type 2 diabetes.

The food environment is certainly different for different groups in society and socioeconomic status has been found to be an important factor in overweight. The highest prevalence of overweight among infants and young



children in the world is in upper-middle-income populations, while the fastest rise in overweight is in the lower-middle-income group (World Health Organization, 2011). In Europe, the highest prevalence of overweight among school children up to ten years was found in Italy, Portugal and the Czech Republic and the lowest in Belgium and Sweden (European Commission, 2010). Environment-level interventions that support behaviour change, according to a recent review on the influences of the food environment on overweight and obesity in young children (Osei-Assibey et al., 2012) include increasing the availability of smaller portions, providing alternatives to sugar-sweetened soft drinks, and reducing food promotion (unhealthy food advertisements) to young children.

## Television in time

Since the advent of television in the last century, its popularity has grown and it has become a natural part of everyday life. In its early days, TV was labelled “an intruder” or “a menace” among other names, to later be valued as a companion and becoming a common point of reference of modern societies (Broddason, 1996) (pp. 5-34). The theories on the influence of mass media have moved from the “hypodermic needle model” coined by Lasswell nearly a century ago (Wartella & Reeves, 1985), which assumed that mass media messages have direct and undifferentiated effects. Towards theories that acknowledge what different audiences bring to the mass media, that is uses and gratifications of TV (Lowery & DeFleur, 1995) (pp. 241) and acknowledge complex influence where media can contribute to the audience’s perception of social reality (Gerbner, 1998; Gerbner, Gross, Morgan, Signorielli, & Shanahan, 2002). The latter is the view taken in this thesis.

Research within various disciplines supports the basic assumption made in this thesis, i.e. that the TV audience is affected by the messages mediated. It is acknowledged that the audience is a part of larger society and community and brings this to the TV set. Children begin watching TV before they begin reading and even before they can talk. Cultivation theory assumes that “television viewing both shapes and is a stable part of lifestyles and outlooks” (Gerbner, 1998). “Everyday social life is strongly patterned by the routines of media use and infused by its contents through the way leisure time is spent, lifestyles are influenced, conversation is given its topics and models of behaviour are offered for all contingencies” (McQuail, 2005) (p. 4).

In cultivation theory, the concept of cultivation is used to “describe the independent contributions television viewing makes to viewer conceptions of social reality” (Gerbner, 1998). According to cultivation theory, there is a difference in conceptions of reality between light and heavy viewers in the same demographic subgroups. “Light” and “heavy” viewing are not absolute numbers but used in relative terms; thus the determination of what is “light” or “heavy” viewing is made on the basis of each sample when doing cultivation analysis. The use of the term “cultivation” does not imply a one-way process or another word for effects. The influences are subtle, complex and intermingled with other influences. The cultivation theory perspective assumes an interaction between the medium and its public, whether it is adults, adolescents or children. In his essay (Gerbner, 1998), Gerbner explains and discusses the divergences between symbolic reality and “objective” reality. An example is that TV drama tends to underrepresent older people, whereas the group over 65 is a rapidly growing segment of the real-world population in the US and Europe. Heavy viewers were more likely to feel that the elderly were a “vanishing breed”, and this is contrary to fact. Relations are assumed between more TV viewing and people’s perceptions about the world reflecting the images seen on TV (Signorielli & Staples, 1997). Another example could be the depiction of overweight in TV shows, where the prevalence is much lower than in reality, in addition to negative framing such as individual blame (Ata & Thompson, 2010), which could affect audience’s assumptions of reality. Findings from a recent experimental study indicated that more positive media portrayals of obese individuals might help reduce weight stigma (Pearl, Puhl, & Brownell, 2012).

The nature of screens is changing at an unprecedented rate. Not only adults have the possibility of screens at hand at nearly all times, but young children as well. Phones, tablets, computers and TV screens reflect the users’ search for entertainment and information, as the viewers themselves increasingly set the programme (Marsh et al., 2013). Television is a part of the mass media supply available, and is as such important to study. In this thesis it is acknowledged that new media has taken their place in the media landscape. A rapidly exploding “marketing ecosystem” has developed, where new media play a larger role, as well as innovations in digital marketing to young people (Montgomery & Chester, 2007). However, Cairns et al. (Cairns et al., 2009) state that TV still dominates in food marketing. In Sweden, TV viewing in the youngest age group (2-9 years old) has furthermore been stable during the last

years (2010-2013) with 65-70% watching every day (Swedish Media Council, 2010, 2013).

In Sweden watching TV is the second most popular activity in 2-9 year-old children's free time, as 67% watch TV or DVD after school every day, and 67% watch TV more than one hour every day (Swedish Media Council, 2013). Of the younger children (2-4 years old) 65% watch TV or films every day after preschool according to the most recent statistics from Sweden on how the youngest children use media (Swedish Media Council, 2013), and 64% watch at least one hour. Of the 5-8 year-olds, 69% watch TV every day, 71% at least one hour per day. One in four babies 0-1 years watch TV every day, 18% at least one hour. TV viewing in Sweden among children aged 3-14 years has stabilised around a mean viewing time of 100 minutes/day during recent years, of which 37-39 minutes were spent viewing public service channels, according to Media Audience Measurement in Scandinavia (MMS, 2011, 2012). The most popular TV programme among children in the age group 2-9 years (Swedish Media Council, 2010, 2013) is aired on a public service TV channel, which is commercial-free.

Children's TV viewing has received attention ever since television's appearance in the last century. If the attention was not for violent influence, then it was for influence on unhealthy food habits. This thesis acknowledges that TV has an influence on its audience, an influence that can be both positive and negative. The American Academy of Pediatrics (AAP) recognises the important positive and pro-social effects of media use but is, at the same time, concerned by the potential harmful effects of media messages and discourages media use by children younger than two years of age (American Academy of Pediatrics, 2011, 2013).

## Summary

Previous research has shown that TV and computer use might affect childhood overweight and children's food habits. Several mechanisms have been proposed behind the associations between screens and overweight including sedentary behaviour, eating while viewing, and exposure to commercials. Some aspects of the association between TV viewing and food habits/anthropometry have received less attention than others, for example the underlying social factors and the possible confounding factors of social norms in the family that can affect children's lifestyle. TV has the potential to

influence children's attitudes and habits regarding food and beverages. TV commercials for food and beverages have been extensively studied, and it is important to study the appearance of food in children's TV programmes in a similar way.

# Aims

The general aim of this thesis is to examine the associations between young children’s screen habits, food habits and anthropometry as well as to analyse food and beverages in children’s television programmes in public service television in Sweden (See Figure 2 for an overview).

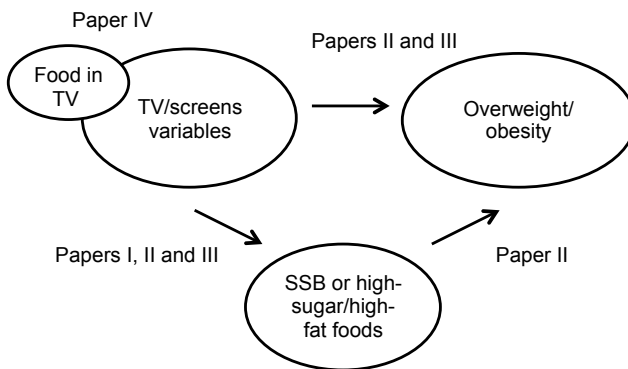


Figure 2. Overview of the thesis.

The specific aims are as follows:

Paper I: To examine the association between young Swedish children’s TV, computer and commercial exposure and their consumption of sweetened beverages, taking into consideration descriptive and injunctive parental norms regarding their child’s sweetened beverage consumption.

Paper II: To examine associations between young children’s TV viewing and other screen activities in relation to changes in consumption of sugar-sweetened beverages and changes in BMI and waist to height ratio in eight European countries.

Paper III: To examine whether children's television habits (watching more than 60 minutes of TV per day, having a television set in the bedroom, and usually watching television during meals) in eight European countries are related to weight status and indicators of high-fat and high-sugar dietary patterns. Also to examine whether the associations can be explained by children's individual taste preferences for fat and sugar.

Paper IV: To examine the nature and extent of verbal and visual appearance of food and beverage in children's programmes in Swedish public service television, by analysing frequency and type of foods, determining in what context more or less healthy foods appear, and identifying messages on health and taste.

# Methods

This thesis includes four quantitative studies (see Table 1 for overview). Data from the European research project IDEFICS (Papers I-III) is used, contributing to one of the main headings in the thesis: *Cross-sectional and longitudinal associations between screens, food habits and anthropometry*. The other main heading is *Food in children's television*, which reflects on the other data source, which is content from public service television in Sweden. The main headings run through the Methods and Results sections as a natural division of the text.

Table 1. The studies in the thesis.

Study	Sample	Design	Data	Nutritional focus	Screen focus
<b>Paper I</b>	IDEFICS 2-9-year-old children Sweden (n=1733)	Cross-sectional Longitudinal	Questionnaire	Intake of sweetened beverages (frequency per week)	TV time (h/day) Total screen time (h/day) Exposure to commercial TV (yes vs. no) Parents intentions to limit TV commercials (yes completely vs. no or partly)
<b>Paper II</b>	IDEFICS 2-9-year-old children Europe (n=16225)	Cross-sectional Longitudinal	Questionnaire Anthropometry	Intake of sweetened beverages (frequency per week) Obesity (BMI, WHtR <sup>1</sup> )	TV time (h/day) Total screen time (h/day)
<b>Paper III</b>	IDEFICS 2-9-year-old children Europe (n= 15144)	Cross-sectional	Questionnaire Anthropometry	High-fat and high-sugar propensity scores Taste preferences Obesity (BMI)	TV time (>60 min/day) Watching TV during meals (always/often vs. never/rarely) TV in bedroom (yes vs. no)
<b>Paper IV</b>	Children's TV programmes broadcasted in Dec 2011 to April 2012 in Sweden (25 h)	Cross-sectional	Broadcasted TV	Verbal and visual appearance of food, especially HCLN <sup>2</sup> foods and FV <sup>3</sup>	Public service commercial-free TV content

<sup>1</sup> Waist to height ratio

<sup>2</sup> High-calorie and low-nutrient

<sup>3</sup> Fruits and vegetables

## Papers I-III: Cross-sectional and longitudinal associations between screens, food habits and anthropometry

### **Data/population/design**

Papers I-III are based on data from the European IDEFICS study. IDEFICS is a large-scale study investigating diet, social determinants and lifestyle factors of 2 to 9 year olds in eight European countries (Estonia, Sweden, Germany, Belgium, Hungary, Italy, Spain and Cyprus). This prospective cohort study started with a baseline survey in 2007-2008, followed by an embedded intervention. Two years later, 2009-2010, a follow-up was performed. Participants were recruited via their day care centres or schools. The examination protocol included a detailed questionnaire in which parents described their children's lifestyles, diets, and family circumstances. At the same time a physical examination of all children was conducted to collect different measurements (see further in (Ahrens et al., 2011)). The anthropometric measures used in the papers of this thesis are weight status, height and waist circumference and the derived variables BMI and waist-to-height ratio (WHtR).

For Paper I, only data from the Swedish part of IDEFICS was used. In Sweden, 2759 children were contacted via their day care centres or schools in three municipalities in the Gothenburg region in western Sweden. The municipalities were chosen with the primary aim of selecting intervention and control regions that were comparable considering infrastructural, socio-demographic and socioeconomic characteristics (Ahrens et al., 2011). 1809 children were included in the Swedish study and 1733 participants had valid data on beverage consumption. The mean age was 5.7 years, and 51.3% were boys. See Table 2 for all relevant variables at baseline described by sex and age group. Data from the Swedish follow-up survey 2009-2010 was used to analyse the influence of exposure to commercial TV on sweetened beverage consumption prospectively. 1333 participants had valid data on beverage consumption for analysis in the follow-up survey. The mean age was 7.7 years and 49.7% were boys.

The analysis in Paper III was limited to baseline data from all participating countries, with a total sample of 15144 corresponding to the number of children who met inclusion criteria and also had data on at least one of the TV



viewing variables used in this analysis. For the analyses in Paper II, data was used from all participants at baseline (n=16225) and from those who had valid data at follow-up (n=11038).

## **Measures/data collection**

### *Questionnaire*

Parents described their children’s lifestyles, diets and family circumstances by completing a detailed questionnaire. Children’s usual consumption of various foods and beverages (excluding foods provided in school or preschool) by parental response was measured by a food frequency questionnaire (FFQ) which was a part of the Children’s Eating Habits Questionnaire (CEHQ). The CEHQ-FFQ was developed as a screening tool to investigate usual food consumption and behaviours associated with weight status and general health in children. It describes the frequency of the child’s consumption of 43 food items from 14 food groups on a typical week during the preceding 4 weeks. The CEHQ-FFQ was designed to reflect intake of foods that are believed to be obesity-promoting or inhibiting, but does not aim to assess total food or energy intake. Evaluation of the CEHQ by checking correlations between milk consumption frequencies and ratios of urinary calcium and potassium, provided significant results (Huybrechts et al., 2011). By collecting the CEHQ-FFQ twice from a subsample and checking correlations, it was concluded that the CEHQ-FFQ gave reproducible estimates of the consumption frequencies of food items reported (Lanfer et al., 2011).

### *Food and beverages*

For Papers I and II, the following question on sweetened beverages was used:

In the last month, how many times did your child eat or drink the following food items? Please refer to the last four weeks and exclude all pre-school or school meals.

- Sugar-sweetened drinks including sport drinks, for example syrup-based drinks (local examples)
- Sugar-free drinks (local examples)

The parents could choose between seven categories when answering, ranging from “never/less than once per week” to “four or more times per day” or “don’t know”. A variable for the combined consumption of sugar-sweetened

beverages (SSB) and artificially sweetened beverages (ASB), carbonated or not, was then created to account for the consumption of what was called sweetened beverages in Paper I. Finally, a dichotomised variant of this variable was created: at least one to three times per week vs. less than once per week. For Paper II, the same question was used, but only the consumption of beverages sweetened with sugar was used for the variable measuring SSB consumption.

For Paper III the weekly consumption frequencies of each of 17 foods and beverages that are high in fat were calculated, as well as 12 high-sugar foods and beverages, based on which a weekly frequency was calculated for each of these categories. The remaining items in the 43-item questionnaire were also converted into weekly frequency scores. A continuous index was developed, using the total weekly frequency for the items high in sugar or high in fat divided by the individual's total consumed food frequencies. These indices are referred to as fat or sugar propensity ratios, as described previously (Lanfer et al., 2012) and were considered to reflect proportions in the whole diet.

### *Screens*

The children's TV, computer and commercial exposure was measured with several questions and resulted in six variables:

a) *Hours per day spent watching TV, videos or DVDs* were measured by the question "How long does your child usually watch TV/video/DVD per day?" Answers were separated by weekdays and weekends and categorised in six categories from "not at all" to "more than three hours per day". An hours per day variable was created by approximating the intervals given for each category in the answers to a decided number. For example "less than 30 minutes per day" was given the label 0.5 and "more than three hours per day" was given the label 3.5. The TV/video/DVD hours during weekdays were then multiplied by five and the weekend hours by two. Finally, this was divided by seven to get the continuous variable of hours per day spent watching TV/video/DVD. TV time was used as a continuous variable in Papers I and II, but dichotomised in Paper III to less than 60 minutes per day vs. at least 60 minutes per day (TV60).

b) *Total screen time* (hours per day spent watching TV, videos, DVD, sitting at the computer or playing computer games) was measured by adding hours a day watching TV/video/DVD with hours a day at a computer screen (measured by the question "How long does your child usually sit at a computer/game console per day?" using the same procedure as in a)), creating

a continuous variable of hours per day in front of a TV or a computer screen (Papers I and II).

c) *Exposure to commercial TV* was measured by the question “Which TV-channels has your child watched during the past month?” (a question added only to the Swedish questionnaire for the purposes of this thesis). Multiple responses of eight channels were possible, whereof two channels were public and not allowed to broadcast commercials according to Swedish legislation. The six additional channels were chosen on the basis of coverage and viewing time (MMS, 2006) in the younger age groups (3-12 years) and by being financed by commercials and not by distribution revenues (The Swedish Broadcasting Authority, 2007). If one or more of the other six commercial channels were filled in, exposure to commercial TV was registered, and thus a dichotomised variable was created: exposed vs. not exposed (Paper I, data only available in the Swedish part of IDEFICS).

d) *Parents’ limitations of children’s exposure to TV commercials* were measured by the question “Do you deliberately attempt to limit your child’s exposure to TV commercials?” (a question only added in the Swedish questionnaire) with three possible answers: “Yes, completely”, “yes, partly”, “no, not at all”. A dichotomised variable was created: completely vs. partly or not at all (Paper I, data only available in Swedish part of IDEFICS).

e) *Watching television during meals* was measured by the question “Does your child watch TV at meals?” with possible responses of never, rarely, sometimes, often and always. Those children whose parents gave responses of never or rarely were classified as not watching TV during meals, while others were classified as positive in this respect (Paper III).

f) *Having TV in bedroom* was based on whether or not the child had a TV and/or DVD or video player in the bedroom (Paper III).

The TV variables a) i.e. TV60, e) and f) were referred to collectively as high-risk TV behaviours in Paper III. These questions were included in a pilot study checking reproducibility of the parental questionnaire where the results suggested agreement among repeat measures.

### *Anthropometry*

Children’s body weight was measured to the nearest 0.1 kg in the morning in fasting condition and wearing underwear (TANITA BC 420 SMA scale). Height was measured to the nearest 0.1 cm (SECA 225 stadiometer). Based on these measures, BMI was calculated, and for the purpose of the present

analysis, dividing body weight in kilograms by squared body height in meters. Children were classified as overweight (including obese) or non-overweight (including underweight) using age and sex-specific cut-points for overweight defined by Cole and colleagues (Cole, Bellizzi, Flegal, & Dietz, 2000). For Papers II and III overweight and obesity was used as an outcome, and in Paper II, BMI z-score was also used, i.e. standard deviation scores close to normal distribution (Cole, Freeman, & Preece, 1998). Waist to height ratio was also used as an outcome in Paper II. Waist circumference was measured at the midpoint between the iliac crest and the lower coastal boarder or tenth rib and recorded at the nearest 0.1 cm for all children. The anthropometric measures were standardised across survey countries and according to a study describing the standardisation and reliability of the anthropometric measures, acceptable intra- and inter-observer agreement was achieved for all measurements (Stomfai et al., 2011). The potential of various anthropometric field methods has been investigated within the IDEFICS validation study (Bammann et al., 2011). Waist circumference as a single field measurement explained 76% of the variance of fat mass (Bammann et al., 2013).

### *Covariates*

#### Parental norms (Paper I)

An indicator for parental norms regarding sweetened beverages was assessed by two questions, which were only added in the Swedish questionnaire and applied to the parent who filled in the questionnaire (mothers in over 80% of the cases). The frequency of parents' consumption of sweetened beverages (descriptive norm) was measured with the same procedure as the children's consumption. The parents' injunctive norm was measured by the question: "How do you feel about your child drinking soft drinks?" with five possible answers: "OK", "quite OK", "neither nor", "quite bad", "bad". Parents who reported approval (injunctive norm) of their child's consumption of sweetened beverages (OK or neither nor) and consumed sweetened beverages themselves at least one to three times per week (descriptive norm), were categorised as having norms favouring consumption of sweetened beverages in a combined norm variable. In order to take parental norms into consideration in an association, it is preferable to focus on a specific food group instead of foods in general, in this case sweetened beverages.

## METHODS

### Parental education (Papers I-III)

For Paper I, the variable for education was dichotomised as above or equal to two years of undergraduate studies versus fewer than two years of undergraduate studies. For Papers II and III the highest educational level attained by either parent was used as an indicator of socioeconomic status and included as a covariate. The education variable was coded according to the International Standard Classification of Education (ISCED) (UNESCO, 2006) with levels 1, 2, and 3 categorised as lower educational attainment, and level 4 and above as higher educational attainment.

### Income (Paper I)

An indicator for socioeconomic status was also assessed by the household's total monthly income, measured in nine categories ranging from below 1,000 € to exceeding 5,500 €.

### Physical activity (Papers II-III)

Half of the multi-centre sample (convenience sampling) wore accelerometers. A variable reflecting time spent performing moderate or vigorous intensity physical activity in minutes (average over all valid days) was calculated (Evenson, Catellier, Gill, Ondrak, & McMurray, 2008) and used as a covariate in a subsample analysis in Paper III. In Paper II, this variable was also used and in addition in analysis with weight status as a dependent variable, we further adjusted for two indicators of physical activity. All parents were asked to report their children's usual patterns of outdoor play and indoor sports; based on this a physical activity indicator was created.

### Siblings (Paper I)

Having older siblings was taken into account in Paper I and measured with a dichotomised variable: living with one or more older siblings versus not living with older siblings.

### Taste (Paper III)

A subsample of six-to-nine-year-old children underwent sensory testing in the schools, as reported previously (Lanfer et al., 2012).

## Data analyses

Logistic regression was used to estimate associations in Papers I-III. Statistical calculations were performed with PASW, SPSS and SAS statistics programmes.

In Paper I logistic regression was used to analyse the association between the children's TV, computer and commercial exposure and their consumption of sweetened beverages, where the beverage consumption was the dependent variable. Logistic regression was chosen as an analysis method, as the frequencies turned out to be naturally dichotomised to fewer than once per week vs. at least one to three times per week, both at baseline and follow-up. All four variables for TV, computer and commercial exposure were analysed in separate models. In each of these models, adjustments were made for age, sex, having older siblings, child's weight status, parental education, income, and parental norms on sweetened beverages. The combined variable for favouring parental norms on sweetened beverages was used for adjusting in all models, due to collinearity when using two separate norm variables in the same model. The analyses were also stratified by sex and age groups. Logistic regression was also performed for testing the hypothesis that exposure to commercial TV at baseline predicts consumption of sweetened beverages at follow-up, with adjustments for consumption of sweetened beverages at baseline, TV viewing time, as well as age, sex and intervention. Furthermore, possible mediating effects of parental norms on sweetened beverages were tested. No intervention effects on beverage intake were detected and, therefore, data from both intervention and control groups were analysed in the same model for Paper I.

Logistic models were used in Paper III to calculate prevalence odds ratios (ORs) for overweight (including obesity) as a function of the three TV indicators (TV60, watching TV during meals and having a TV in the bedroom). The model was adjusted for survey country, parental education, age and sex. In a fully adjusted model, the two diet indicators (fat and sugar propensity ratios) were simultaneously added as continuous covariates to the previous model and additionally adjusted for the other two TV variables and physical activity.

In Paper II, to test the hypothesis that TV viewing and other screen activities at baseline (h/day) predicted changes in anthropometric measures, logistic regression models were used where the outcomes of a dichotomous dependent variable were: the highest quintile of relative change in BMI from

baseline to follow-up versus all the other quintiles; the highest quintile of relative change in WHtR versus other quintiles; and the highest quintile of actual change in BMI z-score, defined according to Cole and colleagues (Cole et al., 1998), from baseline to follow-up, versus all the other quintiles. The highest quintile was used to indicate more than minimal change in all the anthropometric measures.

To test the hypothesis in Paper II that TV viewing and other screen activities at baseline predicted changes in consumption of sugar-sweetened beverages, logistic regression models were used with relative changes in consumption between baseline and follow-up as the basis for a dichotomised dependent variable with the following outcome: relative increase in consumption of sweetened beverages from baseline to follow-up (versus unchanged or decreased consumption).

For the above mentioned prospective analyses in Paper II, the variable indicating relative change (% change) in the three outcome variables (BMI, WHtR and consumption of SSB) between baseline and follow-up was created by dividing the actual change between baseline and follow-up by baseline frequencies. Consequently, adjustments were not made for the baseline values in the regression models calculating the prospective associations. As absolute changes in BMI z-scores were calculated (i.e. not relative), analyses, including changes in BMI z-scores were adjusted for baseline values. In addition to analyses on changes in anthropometric measures over time, cross-sectional analyses of overweight and central obesity at baseline were performed in Paper II. In cross sectional analyses, dichotomous outcomes were defined as a) being overweight (including obese by measure of BMI categories according to Cole) vs. normal or underweight, and b) having WHtR above 0.5 vs. equal or below 0.5. Models were adjusted for age and sex of the children, parents' education, intervention and physical activity in a subsample. All analyses were performed for the full sample and control group as well as stratified for each survey centre (country) and two age groups.

## **Ethics**

All survey centres obtained approval from their local research ethics committees or institutional review boards. All applicable international ethics regulations were followed during this research. Informed consent was obtained from the children's parents, one of whom was usually present at the examination.

## Paper IV: Food in children's television

### Data

Paper IV is based on content from public service television in Sweden (children's programmes). The study object was the most popular children's TV programme in Sweden, "Bolibompa" (based on ratings (MMS, 2011, 2012) and two recent questionnaire surveys to parents of two to nine year olds (Swedish Media Council, 2010, 2013)). The show is broadcast every morning (2 hours) and every evening (45 minutes) of the week on the Children's Channel (SVTB), one of eight channels operated by the SVT public service broadcasting company. One-third of children ages 3-14 watch the channel daily (MMS, 2012) and 45% of the two to nine year olds most often watch "Bolibompa" (Swedish Media Council, 2013). "Bolibompa" consists of various programme sections, such as films, cartoons etc., produced in Sweden or other countries, as well as studio sections. Presenters in the studio introduce each programme section, discuss them, play games etc., according to the assignment from the Children's Channel (SVT, 2011). The studio sections within the show contain presentations of films and cartoons as well as longer studio sections, where the host, for example, performs some activity or tells a story.

Based on ratings from 2010 (MMS, 2010), the most popular TV viewing months (December to April) were chosen for the sample. The analysed material consisted of 24 hours and 45 minutes, broadcast over a period of four months during the winter 2011-2012. To collect material from each day of the week and each month of the period, two days in a row with three-week intervals were chosen to represent all days of the week twice, beginning with a Saturday and a Sunday in December 2011, and ending with a Thursday and a Friday in April 2012. Both days in a row were sampled for the shorter evening programmes and the second day for the longer morning programmes. This resulted in 10 hours and 45 minutes of evening programmes, where each day of the week was represented twice, as well as 14 hours of morning programmes, where each day of the week was represented once.

A total of 287 programme sections (studio section, cartoon or film) ranged from 5 seconds to 29 minutes, with a mean length of 5 minutes and 15 seconds. A total of 50 sections were 30 seconds or shorter and 72 sections were 10 minutes or longer in duration. The duration of the studio sections



was shorter compared to other programme sections. Studio sections accounted for approximately 15% of the time or a total of 3 hours and 40 minutes. Other programme sections accounted for the remaining 21 hours and 5 minutes airtime in the sample. The duration of food appearances on air was not calculated as they varied in explicitness and frequency within and between programme sections.

## Measures

All appearances of food and beverages in the material were coded. Food appearances included all kinds of food or beverages that humans might be expected to consume as well as associations to meals. Food appearances were coded in 145 categories, and coded on the basis of each programme section (total of 287), i.e. the same food could appear more than once in each programme section but was only coded once.

Only foods that might be associated with humans or human-like characters were coded, thus leaves or insects eaten by animals were not coded. However apples or carrots or such eaten by animals were coded, as these are foods that humans also eat. Foods that were a part of the background landscape were not coded (e.g. fruit on trees, fish in sea/lake) unless they were explicit or talked about in terms of food.

Each food appearance was furthermore coded according to:

*Display:* Categories included whether the food appearance should be coded as verbal (someone mentioning a food item), visual (food item showing), or both.

*Representation:* Categories assessed whether the food appeared passive in the background, passive but explicit, someone handling the food (hold, give, get, buy, cook, crave) or someone eating/drinking the food in question.

*Age and gender:* Two variables assessed age (children/teenager or adults) and gender of the characters appearing with the food. It was also noted if the food appeared with both age groups or both genders or without character context.

*Message:* Messages on health (healthy or unhealthy) or taste (palatable or unpalatable) were coded if clearly identified with the food.

Descriptions and comments were written for each of the food appearances. Explicit messages on food or beverage being palatable or unpalatable were identified, categorised and described. These were verbal messages or identified in other ways that were clearly expressed, e.g., a sigh when eating or drinking.

Also, verbal messages on food or beverage being positive or negative for health and wellbeing were identified, categorised and described.

## **Analyses**

Food appearances during 24.75 hours of children's programmes broadcast in public service television during five months were coded. The initial 145 categories of food appearances were further aggregated into 23 food groups. Two food groups, which could be of interest from a health perspective, were analysed further:

1. Fruits and vegetables: fruit, berries, vegetables, root vegetables, juice.
2. High-calorie and low-nutrient foods (HCLN): cookies, confectionaries, sweet beverages, desserts, jam, ice cream, sugar, snacks, alcohol.

Foods that are nutrient poor and high in fat or sugar have different collection names, not all capturing the whole picture: energy-dense foods, snacks, calorie-dense foods, or nutrient-poor foods. The concept "high-calorie and low-nutrient foods" (HCLN) is used, capturing both the energy density and nutrition poverty that foods and beverages, such as soft drinks, confectionaries, chips and cookies have in common.

Chi square tests and the Mann-Whitney test were performed for estimating the difference between the settings in which two kinds of foods, fruits and vegetables and HCLN foods, appeared. A probability value of less than 5% was considered to be statistically significant. Coding and analyses were performed with the statistical programme SPSS version 21.

# Results

## Cross-sectional and longitudinal associations between screens, food habits and anthropometry

### **Descriptive results**

In Paper I data from the Swedish IDEFICS was used. The distribution of the frequency of consuming sweetened beverages at follow-up was very similar to baseline, i.e. 56% consumed the beverages at least one to three times per week, even though the children were two years older. See main descriptive results for all the relevant variables at baseline in Table 2. Of all the children in the Swedish sample, 53% watched TV for more than one hour a day, while only 6% watched more than two hours. After the age of three years, the results of this parent-reported data indicate an increase by age group in the consumption of sweetened beverages, TV viewing time and exposure to commercial TV (Table 2). Some significant gender differences were also found ( $p < 0.05$ ). More boys than girls consumed sweetened beverages at least one to three times per week. The boys also had longer total screen time and more exposure to commercial TV than the girls. Approximately one-half of the sample had one or more older siblings (53%). The percentage of parents whose education extended beyond two years at the undergraduate level was 59%. Fifty per cent had a household income in the category of 3000-4000 € a month after taxes, whereas 25% had lower income and 25% had higher income. Approximately 10% of the children were overweight or obese.

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Table 2. Descriptive data of TV, computer and commercial exposure, sweetened beverage consumption and parental norms. Swedish sample.

Variable	Girls					Boys					Total All age groups
	2-2.9 n=84	3-4.9 n=240	5-6.9 n=225	7-9.5 n=295	<i>p</i> for trend (age)	2-2.9 n=111	3-4.9 n=248	5-6.9 n=230	7-9.5 n=300	<i>p</i> for trend (age)	
<b>Sweetened beverages</b>											
At least 1-3 times/week, child %	42	53	55	59	.01	51	59	61	65	.01	57
At least 1-3 times/week, parent <sup>1</sup> %	45	47	46	40	0.2	48	49	48	46	0.5	46
Parent's approval of consumption <sup>2</sup> %	17	26	28	36	<.001	23	28	31	30	0.2	29
Favouring parental norms <sup>3</sup> %	11	18	17	16	0.6	14	19	20	18	0.5	17
<b>TV, computer and commercial exposure</b>											
TV >1 h/day, child %	34	49	57	57	<.001	28	54	60	58	<.001	53
Total screen time >1 h/day, child %	37	63	81	92	<.001	32	76	92	98	<.001	79
Exposure to commercial TV, child %	46	55	69	87	<.001	41	63	78	92	<.001	72
Parent not or partly limiting exposure <sup>4</sup> %	74	82	82	93	<.001	73	83	90	94	<.001	86

<sup>1</sup> Descriptive norm

<sup>2</sup> Injunctive norm

<sup>3</sup> Combined variable of descriptive and injunctive parental norms

<sup>4</sup> Parent not or partly limiting child's exposure to TV commercials.

The data for Paper II and III were from all eight study centres. Descriptive statistics regarding parents' education, anthropometry, physical activity, screen time and dietary habits of the full sample can be viewed in Tables 3-4.

Table 3. Selected socio-demographic characteristics in full sample and physical activity in a subsample, by country.

	EST	SWE	GER	BEL	HUN	ITA	ESP	CYP	ALL
<b>N<sup>1</sup> at baseline</b>	1719	1809	2065	1926	2569	2250	1507	2380	16225
<b>N for accelerometer data</b>	1106	548	1080	495	1648	837	1253	484	7451
<b>Mean age (std)</b>	5.9 (2.1)	5.7 (2.0)	6.2 (1.8)	5.7 (1.6)	6.3 (1.8)	6.1 (1.8)	5.8 (1.8)	6.1 (1.4)	6.0 (1.8)
<b>Girls (%)</b>	50.6	48.4	49.1	49.2	49.9	48.2	48.7	48.5	49.1
<b>Higher education<sup>2</sup> (%)</b>	57.5	79.4	36.9	68.4	52.8	18.4	62.7	82.1	56.0
<b>MVPA<sup>3</sup> min/day mean (std)</b>	39.5 (20.3)	46.0 (22.3)	44.2 (23.0)	36.9 (17.6)	37.2 (19.6)	29.8 (18.6)	41.2 (21.5)	34.4 (18.3)	38.8 (20.9)

<sup>1</sup>IDEFICS inclusion criteria: valid data for age, sex, weight and height.

<sup>2</sup>Either parent with a level 4 or above according to ISCED.

<sup>3</sup>Moderate to vigorous physical activity. Data from accelerometers from participants in a subsample.

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The prevalence of being overweight or obese was higher at follow-up than baseline in all countries (Table 4) and in both intervention and control groups. The prevalence was lowest in the northern countries and by far the highest in Italy. Between baseline and follow-up, the BMI z-score increased for 61% of the children and decreased for 39%. BMI increased for 69% of the children and decreased for 28%. The cut point for highest quintile of relative change (%) in BMI was 11% increase. WHtR increased for 26% of the sample and decreased for 63%. The cut point for the highest quintile of relative change in WHtR was plus 2.5%. In Estonia and Belgium, more than half of the sample consumed sugar-sweetened beverages at least once a week, both at baseline and follow-up. In the southern countries of Cyprus and Spain, the prevalence was lower, where around 20% of the sample reported consuming sugar-sweetened beverages at least once a week, both at baseline and follow-up (Table 4). Between baseline and follow-up, 21% of the children decreased their SSB consumption frequency per week, and 19% consumed SSB more often than at baseline. The data indicates a decrease in overall SSB consumption from baseline to follow-up in the full sample (in both control and intervention groups) in spite of the children growing older. Of the full sample, 55% watched TV for more than one hour a day at baseline (range between different study centres 45-67%) and the total screen time exceeded one hour a day for 73% of the sample (range 64-83%). At follow-up, the children in all countries had increased their TV and screen activities as 62% watched TV at least one hour a day (range 46-75%) and 86% exceeded one hour in total screen time per day (77-93%). See Table 4.

Table 4. Anthropometric data and variables measuring habits for SSBs, TV and screen activities by country for included children at baseline and follow-up two years later.

	EST	SWE	GER	BEL	HUN	ITA	ESP	CYP	ALL
<b>N<sup>1</sup> (n control group) baseline</b>	1719 (926)	1809 (907)	2065 (887)	1926 (950)	2569 (1292)	2250 (1068)	1507 (709)	2380 (1007)	16225 (7745)
<b>N<sup>2</sup> (n control group) follow-up</b>	1334 (700)	1511 (732)	1195 (516)	1253 (599)	1247 (634)	1548 (685)	1207 (582)	1743 (865)	11038 (5313)
<b>Anthropometric data:</b>									
<b>Overweight/obese (%)</b>									
baseline	14.4	10.8	15.9	8.7	17.0	42.0	20.6	23.4	19.6
follow-up	16.0	11.9	17.1	10.5	18.6	50.6	24.7	29.8	23.2
<b>BMI mean (std)</b>									
baseline	16.2 (2.21)	15.9 (1.73)	16.2 (2.15)	15.6 (1.73)	16.2 (2.60)	18.0 (3.24)	16.5 (2.15)	16.6 (2.59)	16.4 (2.49)
follow-up	16.7 (2.88)	16.3 (2.15)	16.7 (2.75)	16.0 (2.04)	16.8 (3.16)	19.4 (3.93)	17.3 (2.71)	17.7 (3.30)	17.2 (3.13)
<b>WHR &gt; 0.5 (%)</b>									
baseline	16.9	17.1	9.9	16.1	17.5	36.8	25.0	29.1	21.4
follow-up	9.5	6.1	7.4	9.2	11.7	37.8	13.7	21.5	15.4
<b>WHR mean (std)</b>									
baseline	0.458 (0.045)	0.460 (0.044)	0.447 (0.041)	0.460 (0.042)	0.461 (0.049)	0.491 (0.055)	0.473 (0.045)	0.482 (0.050)	0.467 (0.049)
follow-up	0.442 (0.045)	0.438 (0.038)	0.436 (0.043)	0.447 (0.042)	0.444 (0.047)	0.490 (0.062)	0.453 (0.043)	0.468 (0.051)	0.454 (0.051)
<b>Screen and dietary habits:</b>									
<b>SSB &gt; once per week (%)</b>									
baseline	50.6	52.3	51.5	50.9	44.5	42.5	18.8	20.8	42.5
follow-up	51.1	49.2	48.3	54.3	38.2	40.8	22.5	23.9	41.0
<b>TV viewing &gt; 1 h/day (%)</b>									
baseline	65.4	53.6	45.2	51.0	53.0	59.6	44.5	66.6	55.1
follow-up	71.1	63.9	45.7	56.4	56.3	65.6	51.6	75.1	61.7
<b>Total screen time &gt; 1 h/day</b>									
baseline	83.4	78.3	65.0	68.5	70.5	76.2	63.2	77.2	72.9
follow-up	91.9	92.7	78.2	83.1	82.4	88.7	77.3	90.2	86.2

N may vary slightly by variables

<sup>1</sup>IDEFICS inclusion criteria: valid data for age, sex, weight, height.

<sup>2</sup>Only including those who also have data at baseline.

## Screens and food habits

### *Cross-sectional analyses*

The results suggest that as the time spent viewing TV increases, so does the frequency of drinking sweetened beverages (Paper I). The associations between watching TV and consuming sweetened beverages or favouring high-fat or high-sugar foods have some resemblance. The results from Paper I suggest that as the time spent viewing TV increases, so does the frequency of drinking sweetened beverages, in a dose-response manner (Figure 3). In Paper III, TV viewing patterns differed significantly among children with different dietary propensity scores, with strong indications of a linear gradient where the likelihood of having each TV habit (eat while watching, having a TV in bedroom, and watching more than 60 minutes per day) increased by quartiles of high-fat and high-sugar propensity.

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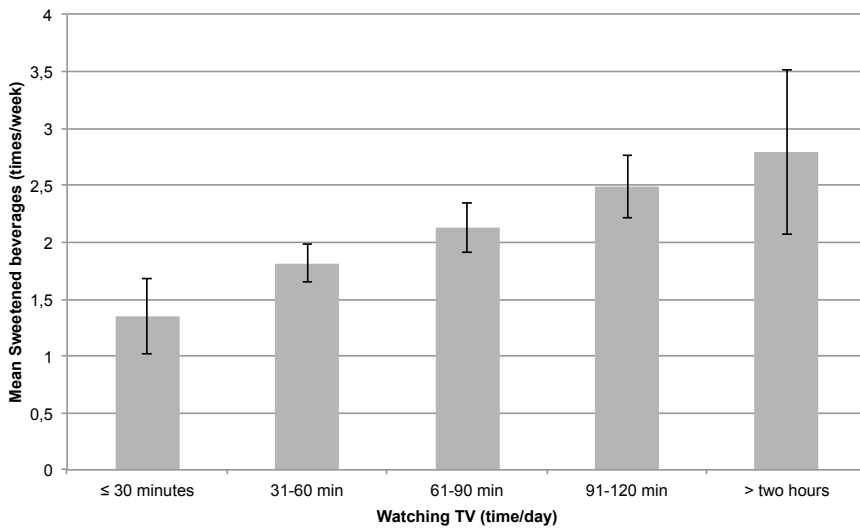


Figure 3. The association between consumption of sweetened beverages and watching TV (95% CI). Swedish sample.

Different possible confounders were taken into account in the analyses in Paper I. For example, parental norms on sweetened beverages, where the hypothesis was that parents who would limit sweetened beverages might also be disposed to limit TV viewing and thus confound the possible association between the independent variable of TV/screens and the dependent variable of more frequent sweetened beverage consumption. The association was present and by adjusting for the confounder it was possible to conclude that the association was independent of that confounder. That is not to say that the confounder did not relate to the dependent variable; on the contrary, the parental norms' variable was highly associated with sweetened beverage consumption.

The association between parental norms regarding sweetened beverages and the children's consumption was strong. The descriptive norms (parent's consumption) had a stronger association with the children's consumption of sweetened beverages (OR 4.5, 95% CI 3.6-5.6) than injunctive norms (parent's approval of consumption) (OR 2.1, 95% CI 1.6-2.6). In further analyses where parental norms were adjusted for, a variable for combined descriptive and injunctive norms was used due to collinearity.

Associations were found between young children's TV viewing (and screen use) and consuming sweetened beverages more frequently (Papers I and II). The likelihood of drinking sweetened beverages at least weekly increased by 50% for each hour a day spent watching TV, when adjusted for parental norms on sweetened beverages as well as age, sex, socioeconomic variables, older siblings, and child's overweight (Paper I). The likelihood of drinking sweetened beverages at least weekly was more than double when parents did not or only partly attempted to limit exposure to TV commercials, as compared to limiting the exposure completely (Paper I).

The odds ratios for crude and fully adjusted models for each of the TV variables are found in Paper I in this thesis while Tables 5a-b are an extended version of that. Table 5a shows odds ratios for the most important variables studied in crude and adjusted associations, while in Table 5b odds ratios for all variables included in the model with exposure to commercial TV and TV viewing time as the explaining variables are given. Associations between consuming sweetened beverages more often and other possible confounders besides parental norms were found, for example, with having older siblings, both in crude (OR 1.39, 95% CI 1.15-1.68) and adjusted models (1.32, 95% CI 1.07-1.62). The association between total screen time (h/day) and the dependent variable of consuming sweetened beverages at least one to three times a week was somewhat weaker than for TV viewing, with odds ratio of 1.38 (95% CI 1.17-1.63) in fully adjusted models. The likelihood of consuming sweetened beverages at least one to three times a week was almost double for the children having parents who did not or partly limit their exposure to TV commercials (OR 1.94, 95% CI 1.43-2.64 in fully adjusted models).



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Table 5a. Odds ratios (95% CI) for associations with the dependent variable of consuming sweetened beverages at least one to three times a week in crude models and each of the explaining variables in the five fully adjusted models<sup>1</sup>. Swedish sample.

	Crude OR	Fully adjusted OR
<b>TV viewing (h/day)</b>	1.65 (1.36-2.00)***	1.52 (1.23-1.87)***
<b>Total screen time (h/day)</b>	1.52 (1.33-1.74)***	1.38 (1.17-1.63)***
<b>Exposure to commercial TV</b>	1.83 (1.48-2.26)***	1.64 (1.28-2.09)***
<b>Parent not or partly limiting exposure to TV commercials</b>	2.26 (1.71-3.00)***	1.94 (1.43-2.64)***
<b>Favouring parental norms on SB</b>	3.56 (2.62-4.84)***	3.62 (2.64-4.96)***

<sup>1</sup>In all associations adjusted for age, sex, siblings, parental education and income. In associations with TV variables, additionally adjusted for child's overweight and parental norms on SB. In the last two TV variables also adjusted for TV viewing (h/day).

\*Significant association p<.05

\*\*Significant association p<.01

\*\*\*Significant association p<.001

Table 5b. Odds ratios (95% CI) for all variables in the full model for association between TV viewing and the dependent variable of consuming sweetened beverages at least one to three times a week. Swedish sample.

Variables	OR (95% CI)
Exposure to commercial TV	1.64 (1.28-2.09)***
TV viewing (h/day)	1.48 (1.20-1.83)***
Favouring parental norms on sweet drinks	3.55 (2.59-4.88)***
Age (years)	1.03 (0.97-1.08)
Sex (being girl)	0.82 (0.67-1.01)
Having older siblings	1.32 (1.07-1.62)*
Being overweight or obese	0.98 (0.70-1.38)
Household income (9 categories)	1.03 (0.96-1.11)
Parental education over 2 years undergraduate	1.34 (1.07-1.67)*

\*Significant association p<.05

\*\*Significant association p<.01

\*\*\*Significant association p<.001

Eating while viewing TV was associated with an increasing propensity to eat high-fat and high-sugar foods (Paper III). This association was independent of education, age, sex, and country. Similar associations were observed for

watching TV more than 60 minutes per day and having a TV in the bedroom. All three TV indicators tended to be more strongly increasing across quartiles for sugar propensity ratios, compared with corresponding quartiles for dietary fat. For example, watching TV during meals was associated with increased propensity for high-sugar foods with OR for the highest quartile of high-sugar propensity 1.93 (95% CI 1.72-2.16), watching at least 60 minutes per day 1.84 (1.66-2.05) and having a TV in the bedroom 1.74 (1.54-1.97).

The association between diet propensity ratios and TV habits in the subsample that underwent sensory testing was explored, providing mainly similar results as in the full sample. This indicates that taste preference is unlikely to be the mechanism linking TV with propensities to consume sugar and to some extent fat. These results are described in detail in another thesis (Lanfer, 2012), and thus, are not the focus here.

In Paper I, the indicators of TV viewing time and exposure to commercial TV were studied in association with consumption of sweetened beverages. Both were significantly associated with consuming these at least one to three times a week. In the final model for the association between exposure to commercial TV and consuming sweetened beverages, adjustments were made for TV viewing time in addition to adjustments for age, sex, having older siblings, child's weight status, parental education, income, and parental norms on sweetened beverages. Being exposed to commercial TV was still significantly associated with consuming SSB more often (OR 1.64, 95% CI 1.28-2.09), indicating that watching commercial TV was associated with drinking sweetened beverages more frequently, independent of time spent watching TV. TV viewing time was also significantly associated with sweetened beverage consumption, independent of exposure to commercial TV (OR 1.48 for each hour per day watching TV, 95% CI 1.20-1.83,  $p < .001$ ). The conclusion is that both TV viewing time and exposure to commercial TV are associated with more frequent consumption of sweetened beverages, independent of each other.

### *Longitudinal analyses*

According to the longitudinal analysis in Paper I, more frequent consumption of sweetened beverages at follow-up was predicted by exposure to commercial TV at baseline (OR 1.41, 95% CI 1.07-1.87). Longitudinal analyses for Paper II showed significant associations between TV/total screen time at baseline and relative changes in consumption of sugar-sweetened

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beverages between baseline and follow-up. The odds ratio of having increased SSB consumption was 1.19 (95% CI 1.09-1.29) for each hour per day watching TV in the full sample and 1.12 (95% CI 1.06-1.19) for each hour per day in total screen time. When analysed separately among two age groups, the associations with TV and screen activities were only significant in the younger age group (see Table 6). The prediction of TV viewing was significant in three out of eight survey centres and for total screen time in four out of eight survey centres.

### *Sensitivity analysis*

Sensitivity analysis in Paper I was performed adjusting for each variable for parental norms separately (descriptive and injunctive norms) resulting in similar results as when adjusted for the combined parental norms variable. This indicates that the findings are not a result of using a combined variable for adjustment. Analysing children's consumption of SSB separately instead of combined with consumption of ASB, resulted in similar results.

Table 6. Odds ratios (95% CI) for longitudinal and cross-sectional associations between TV/screen activities and anthropometric measures and SSB consumption<sup>1</sup>. European sample.

		BMI	WHtR	SSB
<b>Longitudinal associations independent variables:</b>	<b>Age groups (years)</b>	<b>BMI % increase<sup>2</sup></b>	<b>WHtR % increase<sup>2</sup></b>	<b>SSB % increase<sup>3</sup></b>
TV (h/day)	2-<6	1.23 (1.08-1.40)**	1.32 (1.14-1.52)***	1.30 (1.15-1.48)***
	6-<10	1.21(1.11-1.32)***	1.24 (1.13-1.35)***	1.11 (.99-1.24)
Total screen time (h/day)	2-<6	1.15 (1.04-1.28)**	1.22 (1.09-1.36)**	1.21 (1.09-1.33)***
	6-<10	1.17 (1.09-1.25)***	1.16 (1.09-1.24)***	1.08 (.996-1.16)
SSB (times/week)	2-<6	1.01 (.99-1.03)	1.00 (.98-1.03)	----
	6-<10	1.00 (.99-1.02)	1.01 (.999-1.03)	----
<b>Cross-sectional association: independent variables:</b>		<b>Overweight<sup>4</sup></b>	<b>WHtR &gt;0.5</b>	<b>SSB &gt;weekly</b>
TV (h/day)	2-<6	1.23 (1.11-1.35)***	1.17 (1.07-1.27)***	1.60 (1.48-1.74)***
	6-<10	1.27 (1.18-1.37)***	1.26 (1.15-1.38)***	1.54 (1.43-1.66)***
Total screen time (h/day)	2-<6	1.19 (1.10-1.29)***	1.13 (1.05-1.21)**	1.51 (1.42-1.62)***
	6-<10	1.17 (1.11-1.24)***	1.16 (1.09-1.24)***	1.43 (1.36-1.51)***

<sup>1</sup>Adjusted for age, sex, parental education, intervention and study centre.

<sup>2</sup>Highest quintile of relative change between baseline and follow-up.

<sup>3</sup>Having increased SSB consumption vs. unchanged or decreased.

<sup>4</sup>Overweight or obese according to BMI categories by Cole et al. (2000).

\*Significant association p<.05

\*\*Significant association p<.01

\*\*\*Significant association p<.001

## Screens and overweight

### *Cross-sectional analyses*

Papers II and III found associations between screen use and anthropometric measures (BMI and WHtR). In Paper III, the TV indicators were identified as watching more than 60 minutes per day, having a TV in the bedroom and eating while viewing. All three were related to increased likelihood of overweight (including obesity according to BMI).

According to cross-sectional analysis, the odds ratio of being overweight (including obese) by measure of BMI categories by Cole et al. (Cole et al., 2000) was 1.24 (95% CI 1.17-1.32) for each extra hour per day watching TV and 1.17 (1.12-1.23) for each hour in total screen time. The comparable odds ratio for having WHtR over 0.5 was 1.15 (95% CI 1.08-1.22) for each TV hour per day and 1.10 (95% CI 1.05-1.16) for each hour per day of total screen time. See Table 6 for associations in separate age groups. All four associations (two anthropometric measures with total screen time as well as TV viewing) were significant in the samples from Belgium, Germany and Hungary separately, and the associations between TV/screen time and being overweight according to the measure of BMI was also significant in the Swedish, Estonian and Italian samples.

The TV indicators were significantly related to increased odds for overweight (Paper III). Eating while watching TV was significantly associated with overweight (OR 1.20 (95% CI 1.04-1.40) for boys and 1.35 (95% CI 1.17-1.55) for girls in fully adjusted models). Having a TV in the bedroom showed similar associations: OR 1.39 (1.19-1.61) in boys and 1.23 (1.06-1.42) in girls. Finally, watching 60 minutes a day or more was associated with overweight to a similar degree in both sexes: OR 1.20 (1.05-1.38) in boys and OR 1.21 (1.06-1.38) in girls. All models were adjusted for age, survey country, parental education, dietary propensities, parental reports of physical activity, and the other two TV variables.

### *Longitudinal analyses*

Paper II found associations between TV viewing time (and total screen time) and two anthropometric measures, relative increase in BMI and waist to height ratio. Being in the highest quintile of relative change in BMI was predicted by TV viewing and total screen time at baseline according to adjusted analyses in the full sample. The odds ratio of being in the highest

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quintile of relative change in BMI was 1.22 (95% CI 1.13-1.31) for each hour per day spent watching TV for the full sample and 1.17 (95% CI 1.11-1.23) for each hour per day in total screen time. The associations for both TV viewing and total screen time were significant in both age groups (see Table 6 for analyses stratified by age groups). When analysed country by country, the associations were significant for three out of eight survey centres and the same tendency existed in the remaining centres. When analysing associations with changes in BMI z-score (adjusting for baseline BMI z-score), the associations were similar in all aspects. The odds ratio for being in the highest quintile of change in BMI z-score was 1.23 (95% CI 1.14-1.32) for each hour per day watching TV for the full sample, and for total screen time the odds ratio was 1.18 (95% CI 1.12-1.25) for each hour per day.

Relative change in WHtR was another outcome variable in the longitudinal analysis of TV viewing predicting changes in anthropometry. The analysis demonstrated that TV viewing and total screen time at baseline predicted relative increase in WHtR when analysing data from all survey centres together. The odds ratio of being in the highest quintile of relative change in WHtR was 1.26 (95% CI 1.17-1.36) for each hour a day watching TV and 1.18 (95% CI 1.12-1.25) for each hour a day in total screen time. The prediction was significant in combined age groups in four out of eight survey centres separately. Separate models for each country with total screen time as the predicting variable showed significant associations for four out of eight survey centres, and the same tendency held true in the remaining centres.

### *Sensitivity analysis*

In analyses with changes in BMI or WHtR as outcome (Paper II), adjustments were done for physical activity (minutes per day in moderate to vigorous physical activity) in approximately half of the sample that wore accelerometers and this did not affect the results. In Papers I and II, adjustments were done for intervention in longitudinal analyses. When excluding intervention regions from the analyses and only performing analyses on the sample from the control regions, the associations between TV and screen activities at baseline and having increased BMI, BMI z-score and WHtR were slightly weaker than in the full sample, and all associations except the one between total screen time and relative BMI change were significant (see Table 7).

Table 7. Odds ratios (95% CI) for longitudinal associations between TV/screen activities and anthropometric measures and SSB consumption<sup>1</sup> in control group only (n=5313). European sample.

Longitudinal associations independent variables:	BMI % increase <sup>2</sup>	WHtR % increase <sup>2</sup>	SSB % increase <sup>3</sup>
TV (h/day)	1.12 (1.01-1.25)*	1.24 (1.10-1.39)***	1.12 (1.00-1.27)
Total screen time (h/day)	1.06 (.98-1.16)	1.14 (1.04-1.25)**	1.07 (.98-1.18)
SSB (times/week)	1.01 (.99-1.03)	1.02 (1.00-1.04)*	---

<sup>1</sup>Adjusted for age, sex, parental education, and study centre.

<sup>2</sup>Highest quintile of relative change between baseline and follow-up.

<sup>3</sup>Having increased SSB consumption vs. unchanged or decreased.

\*Significant association p<.05

\*\*Significant association p<.01

\*\*\*Significant association p<.001

## Food in children’s television

Paper IV examined the nature and extent of verbal and visual appearance of food and beverage in children’s programmes in Swedish public service television. Of the 287 programme sections studied, 78% (n=224) included food. A total of 773 food appearances were counted in the 224 programme sections, a mean of 3.5 food appearances per program section. The single most frequent food appearance of the 145 foods was coffee, followed by tomatoes, apples, bananas and cakes. When aggregated to 23 food groups, the most frequent food group was fruits and berries (21%) followed by vegetables (18%, including root vegetables), see Figure 4. The food groups coffee and tea (8%), cookies and pastry (7%) and bread and cereals (6%) also appeared rather frequently.

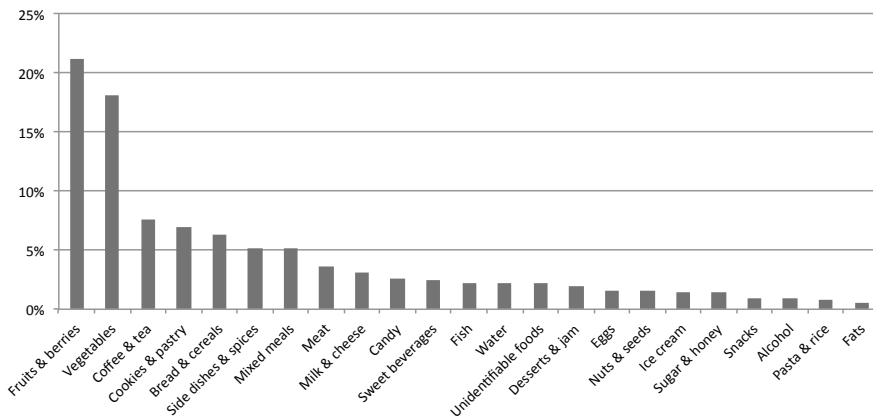


Figure 4. Appearance of 23 groups of foods in children’s TV programmes in Sweden.

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Table 8 shows the context in which foods were shown or discussed. Food appearances were recognised in both studio sections and other programme sections. Foods were most often presented together with people, especially adults and/or males.

Table 8. Food appearances (n=773) by programme section, type, display, representation, gender and age in the children's TV programmes in Sweden.

	Frequency	%
<b>Programme section:</b>		
Studio	196	25%
Films and cartoons	577	75%
<b>Type:</b>		
Animated	314	41%
Not animated	412	53%
Both (animated and not)	47	6%
<b>Display:</b>		
Verbal	148	19%
Visual	426	55%
Both	199	26%
<b>Representation:</b>		
Passive - background	310	40%
Passive - explicit	118	15%
Handle/crave	161	21%
Eat/drink	184	24%
<b>People:</b>		
With somebody	745	96%
With nobody	28	4%
<b>Gender:</b>		
Female(s)	212	29%
Male(s)	282	38%
Both	181	24%
Unable to determine	70	9%
<b>Age:</b>		
Child(ren)	197	26%
Adult(s)	344	46%
Both	116	16%
Unable to determine	88	12%

Together the two groups, fruits and vegetables and HCLN foods, accounted for 58% of the total food appearances. The prevalence of fruits and vegetables and HCLN foods in a different context is shown in Table 9 with p values for differences in contexts.

The HCLN foods were less frequent in the studio, while fruits & vegetables were more frequent there compared to other programmes. The prevalence was not significantly different in animated programme sections compared to other programme sections. We also analysed if these food groups were presented with children or a specific gender to a greater extent. HCLN foods were significantly more frequently presented together with children than adults, while it was the opposite for fruits and vegetables. No significant gender differences were observed. HCLN foods were presented in more active situations, for example eating. In contrast, fruits and vegetables were more often displayed without any people, and more frequently visually than verbally (Table 9).

Table 9. Appearances of high-calorie and low-nutrient foods (HCLN) and fruits and vegetables (FV) respectively, in relation to all food appearances within different settings in the children's TV programmes in Sweden.

	HCLN %	p <sup>1</sup>	FV %	p <sup>1</sup>
<b>Total (n=773)</b>	18.6	-	39.3	-
<b>Programme section (n=773)</b>				
Studio	8.2		58.2	
Films and cartoons	22.2	<0.001	32.9	<0.001
<b>Type (n=726)</b>				
Animated	20.7		35.4	
Not animated	17.5	ns	42.0	0.07
<b>Display (n=574)</b>				
Verbal	21.6		31.8	
Visual	17.6	ns	43.9	0.01
<b>Representation (n=773)</b>				
Active	22.9		31.0	
Passive/background	15.2	0.006	46.0	<0.001
<b>People (n=773)</b>				
With somebody	18.9		38.7	
With nobody	10.7	ns	57.1	0.049
<b>Gender (n=494)</b>				
With female(s)	17.5		41.5	
With male(s)	13.5	ns	41.1	ns
<b>Age (n=541)</b>				
With child(ren)	25.9		34.0	
With adult(s)	14.0	0.001	45.1	0.01

<sup>1</sup> Chi square tests for difference within each setting.



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When comparing how actively the two food groups were represented in an ordinal scale, it was obvious that HCLN foods were more in the foreground and more actively handled (Figure 5). HCLN foods were consumed, handled or craved to a greater extent, while fruits and vegetables were more frequently presented in the background ( $p<.001$ ).

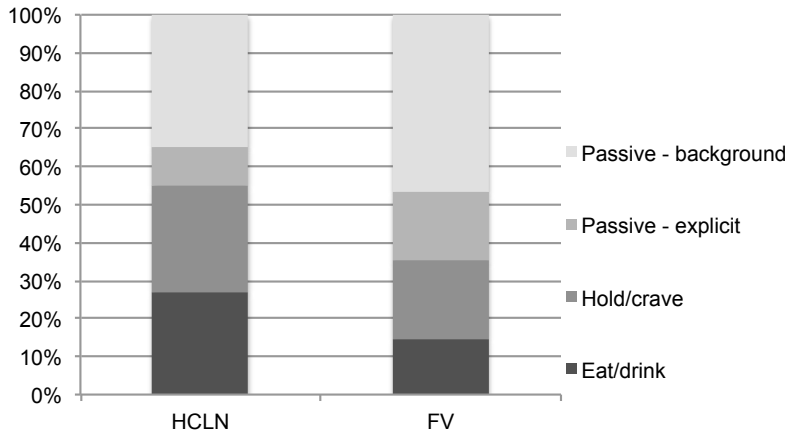


Figure 5. How actively HCLN (high-calorie and low-nutrient foods) and FV (fruits and vegetables) were represented in children's TV programmes in Sweden.

In further analysis, we excluded the studio sections because fruits and vegetables appeared more frequently in the studio and HCLN foods less frequently compared to other programme sections. Studio sections constituted 25% of all programme sections. When only analysing the food appearing in sections other than the studio, the associations with age group were no longer significant. This was true for the HCLN foods as well as fruits and vegetables. Likewise, the association for active/passive appearances became non-significant for HCLN foods.

Fruits and vegetables tended to be more frequently displayed in animated programme sections (35.4%) compared to other sections (27.3%) when the studio was excluded ( $p=0.05$ ) (data not shown). Likewise, the association was reversed for HCLN foods, which had a prevalence of 20.7% in the animated programme sections, and 25.9% in other programme sections, however not significant ( $p=0.2$ ).

Different messages appeared with some of the food (Table 10). Taste messages were present in 11% of all food appearances, mostly indicating palatability. Fruits and vegetables were presented as palatable in 2.3% and HCLN foods in 2.6% of the 773 food appearances. Negative taste messages were also observed. Of all food appearances, fruits and vegetables were presented as unpalatable in 1.2% and HCLN foods in 0.5%. In some cases (1.3%) we detected a health message, i.e. that the food was good or bad for the health. Most of the cases of foods labelled with a healthy message were fruits and vegetables.

Table 10. Messages on taste and health in the food appearances (n=773) in children's TV programmes in Sweden.

Message	% (n)	Most frequently presented with (n)
Palatable	8.4% (65)	Vegetables (15) Mixed meals (11) Cookies (10)
Unpalatable	2.6% (20)	Vegetables (8) Bread & cereals (4) Cookies (3)
Healthy	1.2% (9)	Vegetables (4) Fruits (2) Water (2)
Unhealthy	0.1% (1)	Vegetables (1)

In many cases messages of good taste or enjoyment appeared, most frequently with vegetables, and the second most frequent messages were seen with mixed meals like pizza or breakfast. Messages of bad taste or dislike were also most frequently linked to vegetables. Some examples were, "Carrots, how boring" or "She doesn't like vegetables". Examples of expressions of palatability included, "This is the best tomato sauce I have ever tasted" or "I love lemonade", in addition to expressions of liking the taste like sighing and humming after having taken a sip of tea. The only example identified of expressing that food was "unhealthy" was where two cartoon rabbits were picking mushrooms and discussing this with a bird that did not want to taste, "No thank you, this mushroom is toxic". One of the rabbits becomes very scared, feels bad and imagines he will die. Healthy messages were mostly for fruits and vegetables, and on the overall healthy aspects of eating these. For

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example, Baloo and Mowgli in *The Jungle Book* talked about a nutritious berry “filled with vitamins” that “cures fever”. Another example was a mother in a cartoon with animal characters, talking about the importance of eating regularly as a part of basal needs. “Food is not only something that tastes good or is fun to eat, it helps you grow and your body to create energy. Food is the fuel every animal needs.”

The hosts of the show frequently commented on the content of previous or coming programmes and those comments were often educating. One example was after a cartoon about a little princess who originally did not like her salad, but did so in the end after she had learned to grow her own tomato plant. “I ate that tomato and it was the best tomato I ever tasted. There is something special about the things you grow yourself.” The home-grown principle was both used as a healthy message (in terms of environmental argument for healthy food) and a message of good taste as in this case.



## Discussion

The main findings of this thesis are that TV viewing was found to be associated with sweet drink consumption, increased BMI and waist to height ratio according to cross-sectional and longitudinal analyses. The association between TV viewing and sweetened beverage consumption was found independent of parental norms regarding sweetened beverages. The viewing time was associated with consuming SSB more frequently independently of exposure to commercial TV. The association between TV viewing and drinking sweetened beverages more often can thus not be fully explained by exposure to commercial TV. It was, therefore, interesting to examine how food is displayed on children's TV programmes. It was revealed that one in five foods appearing in the sample of public service commercial free children's TV programmes were for high-calorie, low-nutrient foods, often appearing with children.

### The Ecological model addressed

The results given together provide one piece to the jigsaw puzzle on food habits, childhood overweight, TV time and content and the tangled relations between them. The model introduced in Figure 1 has provided an insight into how the puzzle pieces fit together, even though some are still missing.

The ecological model introduced in Figure 1 (Davison & Birch, 2001) guided the background and has proved useful in examining the associations in this thesis. The model presented has provided a frame for the thesis, although not all issues set forward in the model have been addressed, while some outside the model have. The issues addressed in this thesis in italics: The inside circle of *child weight status* was in focus in two papers, whereas *dietary intake* was in focus in all papers. The other side of the energy balance was taken into account in forms of TV and screen habits (Papers I-III) based on data from children and their parents. TV viewing is one form of *sedentary behaviour* and in a subsample adjustments were made for *physical activity* (Paper II and III). These are energy balance related behaviours of the child. Children's *age* and *gender* were taken into account in all three papers.

Regarding the second circle of the ecological model, describing family characteristics, *peer and sibling interactions* were taken into account and having older siblings was associated with more frequent consumption of sweetened beverages, but did not alter the association between TV viewing and more frequent consumption of sweetened beverages. As with parental norms, the association between having older siblings and consuming sweetened beverages more often was not surprising, as it is well known that older siblings can be role models for the younger ones who might be allowed more TV or sugar-rich foods as found in previous research (Brekke et al., 2007). Children without siblings are however at increased risk for overweight according to other IDEFICS publications (Formisano et al., 2013; Hunsberger et al., 2012).

*Family TV viewing* includes the child's TV viewing, which was central in this thesis in terms of TV viewing time and total screen time as well as exposure to commercial TV, all of which were associated with more frequent consumption of sweetened beverages. Additionally, the first two mentioned were also associated with a relative increase in WHtR and BMI, confirming findings from reviews (Boulos et al., 2012). These are also similar findings to some recent studies examining longitudinal associations, for example from Norway (Gebremariam et al., 2013), which found significant positive associations between change in TV viewing and change in soft drink consumption for 12 year olds. *Parent monitoring of child TV viewing* was also central and having a TV in the bedroom and parents limiting the child's exposure to commercial TV can be identified as part of this issue. Eating while viewing might be added to that list. Limiting screen time for young children is one of the conclusions drawn from the results presented. The likelihood of drinking sweetened beverages at least weekly was more than double when parents did not or only partly attempted to limit exposure to TV commercials, as compared to limiting the exposure completely (Paper I). This strengthens the assumption that it is possible to affect children's food habits by influencing their TV habits. The family and parents have a say in this matter, as limiting opportunities for watching TV and the availability of screens decreases TV watching for the youngest children (Chahal et al., 2012; Santaliestra-Pasías et al., 2013; Van Zutphen et al., 2007).

*Parent dietary intake* is reflected by parental norms on sweetened beverages considered in Paper I. These issues are related to *child feeding practices* and *types of foods available in the home* that most certainly affect the child's *dietary intake*. As for screen habits, the importance of the preschool age range for the

development of dietary habits has been stressed (Bjelland et al., 2013; Jackson et al., 2009). It is not possible to state that it is TV or screens that cause more frequent consumption of sweetened beverages or increase in WHtR or BMI, as is the subject of the studies in this thesis. Longitudinal design in Paper II makes it more logical as more TV viewing at baseline predicts an increase in the anthropometric measures between baseline and follow-up. The other studies have cross-sectional design and to be able to speculate on causality, adjustments for possible confounders are done in order to exclude that a possible association is explained by another variable, such as parental norms on sweetened beverages. The rationale for adjusting for parental norms was that an association between TV viewing and more frequent consumption of sweetened beverages would be explained by parents being permissive about foods as well as TV. This was not the case; the association was independent of parental norms. In previous studies of this kind, adjusting for socioeconomic variables was the usual conduct to be able to get closer to the family lifestyle.

The association between favouring parental norms on sweetened beverages with more frequent consumption of sweetened beverages was measured and found to be strong, which supports previous research suggesting that the family food environment is an important determinant for children's eating behaviours (Campbell et al., 2006). The results were not surprising and in line with studies on the importance of social norms for behaviour that found descriptive norms of greater importance than injunctive norms (Berg et al., 2000). Although both types of norms promote behaviours by providing information about what is approved behaviour in a given situation, injunctive norms are not enough to influence behaviour (Knight Lapinski & Rimal, 2005). However, the purpose of the study was to examine the association between TV/screens and consumption of sweetened beverages, adjusting for the parental norms in a combined variable to see if the association was independent of parental norms. It was indeed, and the conclusion drawn is that what parents do or think about sweetened beverages does not seem to change or affect the association between young children's TV viewing and consumption of sweetened beverages.

In the third circle of the ecological model describing community, demographic and societal characteristics, only *socioeconomic status* is directly addressed in the studies of this thesis as a control variable in all analyses in Papers I-III. No significant associations were found with family income and more frequent consumption of sweetened beverages for the children in Paper

I. However, a significant association with parental education, i.e. a greater likelihood of consuming sweetened beverages more frequently existed when parents had higher education (Table 5b). This might be a surprising association as previous studies have reported a negative association between SES variables and soft drink consumption (Fernández-Alvira et al., 2013) and the more established inverse social gradient in obesity (Magnusson et al., 2014). Other issues from the third circle have been addressed indirectly; such as *leisure time* and *family leisure time activity*, whereas this can include TV viewing. Davison and Birch mention advertisements as influential in the association between TV viewing and increased risk for overweight (Davison & Birch, 2001), as the children are more likely to ask their parents for food items advertised and thus their dietary patterns are affected. The content of the advertisements is, however, outside the parents' control. The obesogenic environment (B. Swinburn et al., 1999) promoting high-energy intake and sedentary behaviours surrounds the developing child and his/her family. According to EST (Bronfenbrenner, 1992), the macrosystem consists of the characteristics of a given culture passed on through processes of socialization and carried out by various institutions of the culture. Mass media are institutions of the culture through which the TV content is broadcast. Content of television is thus seen as part of the macrosystem but not a part of the microsystem where parents are monitoring TV viewing. Thus, the study described in Paper IV concerns the macrosystem to a larger degree than Papers I-III that are concerned with the microsystems.

In summary, the ecological model of predictors of childhood overweight has served as a background model to highlight the most important knowledge from previous research in this complex field. The model presents the characteristics on different levels important for the possible development of childhood overweight, which is a public health concern. Not only the children's intake or expenditure of energy is of importance, even though healthy food and adequate physical activity is central. Family characteristics and monitoring of screen use and dietary intake are not solely to blame either for childhood overweight; neither are societal characteristics on their own. The interaction of all characteristics on all levels is the essence of the ecological model.



## SSB consumption and exposure to screens

Children's SSB consumption has increased during recent decades although with some signs of halting in the most recent years (Kit et al., 2013; Swedish Board of Agriculture, 2012). Data presented in this thesis indicates a decrease in overall SSB consumption from baseline to follow-up in the full sample, whereas a quintile of the children increased consumption. SSB consumption has been receiving attention from public health researchers and health professionals who point out the unhealthy habit of consuming those high-calorie, nutrition-poor beverages and the necessity of decreasing consumption of SSB and increasing water consumption instead. One problem is that these beverages along with other unhealthy foods are heavily marketed, not least to children and adolescents (Boyland et al., 2012; Kelly et al., 2010). According to unpublished data from Sweden, advertisements for sweetened beverages were about 10% of the advertisements aired on commercial channels during the 3-12 year olds peak viewing times, or 0.62 advertisements per hour (based on data from (Kelly et al., 2010)). The associations between TV viewing and increase in SSB consumption were stronger among the younger age groups in the full sample (Paper II), even though indications from the Swedish sample (Paper I) were that exposure to commercials increased with age. This indicates that other TV content besides advertisements might affect the viewers, especially the youngest ones. The associations found in the three studies within IDEFICS indicate that the connections between TV viewing and dietary intake have their origins early in life and support previous studies that have suggested that promotion of healthy diet at an early age is important in order to prevent unfavourable diets later in childhood (Bjelland et al., 2013).

An association between more frequent SSB consumption and increased likelihood of overweight would not have been surprising, but no associations were found in this thesis between being overweight or obese and consuming sweetened beverages more often; thus the hypothesis of SSB consumption mediating the association between TV viewing and overweight was not confirmed in this sample. While preference for sweet food has been associated with overweight in the IDEFICS sample (Lanfer et al., 2012), the same association was not found between SSB consumption and overweight in this study. These relations are, however, very complex, but in line with some previous studies (Clifton et al., 2011). Parallel increase in childhood obesity and consumption of sugar-sweetened beverages has been demonstrated

(Rennie et al., 2005). Systematic review (Malik et al., 2013) and high quality studies have found causal associations between SSB consumption and increased odds for becoming overweight (Dubois, Farmer, Girard, & Peterson, 2007) and between decreasing SSB consumption and lowered body weight (Ebbeling et al., 2006). Leaning on results like those, decreasing children's SSB consumption is an encouraged public health action (Johnson et al., 2012). Even if SSB consumption was not found mediating the association between watching TV and an increase in BMI or WHtR, the conclusions drawn from this thesis' results are, among others, that dietary intake is affected by TV habits. SSBs are one single item in children's diets, whereas the overall diet must be of importance for anthropometry and in turn might be influenced by screen habits. The results from this thesis that show no association between SSB and anthropometry might be a consequence of a reporting bias, i.e., parents may have underreported their children's consumption of SSB due to social desirability, which has been reported to influence accuracy of self-reported dietary intake (Maurer et al., 2006), or they might have had difficulties estimating their child's consumption. Another reason might be that the majority (60%) of the European sample had unchanged SSB consumption frequency between baseline and follow-up.

By analysing total screen time as one variable in the thesis (Papers I and II), it has been taken into consideration that a computer might be used to watch TV and also the time children spend playing computer games or other screen activity. The associations between total screen time and consumption of sweetened beverages or overweight were in all cases weaker than between TV time and the variables of SSB consumption and anthropometry. This is not surprising, as previous research has found similar results (Stamatakis et al., 2013) and playing electronic games has been related to increased energy intake and body composition to a lesser extent than TV viewing (Rey-López, Vicente-Rodríguez, Biosca, & Moreno, 2008; B. Swinburn & Shelly, 2008). The nature of watching TV or playing computer games is different, as TV viewing does not require active hands as playing or doing homework does, and thus promotes snacking while watching. With increased total screen time for the youngest children, the nature of the activities, content watched and games played, may vary even more as pointed out in Nordicom's book, *The Emerging Media Toddlers*. Children six years and younger mostly watch videos and play games, while seven year olds and older use the Internet increasingly for communication (Findahl, 2010). This is an important area for future

research. TV still dominates in food marketing (Cairns et al., 2009) although emerging new media may become an additional venue for advertisements for unhealthy foods. Increased marketing of energy-dense foods aimed at children is a recognised public health problem, and our findings add to the research evidence for the negative effects of marketing aimed at children.

The mechanisms previously suggested to explain the association between TV and overweight, exposure to advertisements on TV, eating while viewing and the sedentary nature of TV viewing, have received most of the attention as large body of research has come to the conclusion that these are the most important aspects of the association (Boulos et al., 2012; Cairns et al., 2009; Halford et al., 2007; Jordan & Robinson, 2008; Lobstein & Dobb, 2005; Osei-Assibey et al., 2012; B. Swinburn & Shelly, 2008; Vik et al., 2013). This thesis supports this conclusion but also aims to highlight that other content in TV besides advertisements might matter, as studied in Paper IV. The results revealed various aspects of interest, for example that HCLN foods were in relative focus in the children's programmes. From a cultivation theory perspective (Gerbner, 1998; Gerbner et al., 2002), viewing this reality could affect the audience's view of the social reality.

## Food in children's television

There is plenty of food appearing in TV watched by children, both in advertisements as previous research has shown and in children's TV programmes as our results reveal. Holding on to the assumption that TV viewing does affect the viewers, television could be an influential setting for health promotion. According to WHO, promoting public awareness about diet and physical activity through mass media is among the most cost effective interventions in preventing non-communicable diseases (World Health Organization, 2011).

According to the results of Paper IV, HCLN foods appeared more often with children than adults, and they were more often shown actively handled than in the background, whereas the opposite was true for fruits and vegetables. Through messages on palatability, HCLN foods were promoted equally to fruits and vegetables, which in turn were presented with multiple messages such as tasting good, bad, healthy and unhealthy. This is somewhat in line with US research, which has shown that the unhealthy foods are more frequent and valued more highly in children's programmes than other TV

programmes (Greenberg et al., 2009; Radnitz et al., 2008). Thereby, the idea of sweets as appropriate for children and “healthy foods” for adults is further rooted in the mind of the viewers, as this seems to be part of the reality broadcast on the show. According to cultivation theory (Gerbner, 1998), such reflection of reality might affect the audience, as cultivation is part of a dynamic ongoing process of interaction among messages and contexts. Social norms, such as celebrating with sweets or giving children soft drinks, may be strengthened via TV content. Instead, healthier alternatives might be promoted.

The health promoting effects of television have not been studied thoroughly yet. Children’s TV programmes are already a setting for health promotion, but could be an even more effective setting for promoting healthy food habits for children. This is not to say that children’s programmes should be indoctrination for never eating anything but certain foods. New studies (Christakis et al., 2013) have encouraged modifying TV content for preschool children towards pro-social content instead of aggressive content. Christakis and colleagues’ intervention study aimed at measuring behaviour outcomes after intervening through the parents with educating and pro-social programmes for preschool children. They made no attempt to reduce viewing time, but focused on the content of programmes. Their randomised controlled trial concluded that an intervention to increase children’s exposure to pro-social programming and reduce their exposure to screen violence was effective and positively impacted children’s behaviour. We argue that independent of content area, the conclusion drawn is relevant: content matters. Others have also stressed the importance of TV’s role in supporting healthy eating messages promoted elsewhere (Klepp et al., 2007).

Picture books are popular among young children in a similar way as cartoons. A recent study found that children (four to six years old) who were exposed to a picture book promoting carrots consumed almost twice as many carrots than children in the control group of an experiment study investigating whether and how a picture book promoting carrots can increase young children’s carrot consumption (de Droog, Buijzen, & Valkenburg, 2013). The results suggested that picture books are effective when children are actively involved (answering questions about the story). Another study by the same authors showed that brand characters could increase children’s liking of fruit up to a level similar to candy (de Droog, Valkenburg, & Buijzen, 2011). This could apply to TV as well. Experimental studies have found it effective to promote healthy food through a favoured character and suggested that

children are more willing to try healthy foods in that way (Kotler, Schiffman, & Hanson, 2012). This is in line with a study on the LazyTown entertainment brand, which demonstrated children's preferences for child-oriented wrappings and suggested that popular brands could be useful to promote healthy eating among young children (Gunnarsdottir & Thorsdottir, 2010). Many characters seen on the "Bolibompa" show can become the young viewers' companions and role models. Portraying healthy eating in children's TV programmes could thus further increase the likelihood of healthy eating.

The "Bolibompa" show was found to portray healthy foods in many ways. Vegetables were, for example, presented with messages of being healthy as well as palatable, even if the reverse were also true. The hosts in the studio introduced home-growing and cooking, commented on healthy or unhealthy foods and the content of programmes etc. The foods that appeared in the studio also seemed consciously chosen from a health perspective with only 8% HCLN foods compared to 22% in other sections of the show. A more health-oriented approach in the studio sections might be one reason why some associations became non-significant when studio sections were excluded. Fruits and vegetables appeared more often in studio sections than in the other sections, as did adults. One explanation for the difference between studio sections and other sections of the show might be that the studio hosts endeavour to promote the healthy foods while the films and cartoons do not. At the same time there are few children present in the studio strengthening the relation between healthy foods and adults. Even though this thesis did not study the effects of this TV content, previous studies indicate that content does matter when it comes to effects on the audience, as not only advertisements have found to be effective (Bickham et al., 2013; Marsh et al., 2013).

## Responsibility

This thesis is not concerned with analysing parenting styles or with identifying parents as "responsible" for the development of overweight. Rather, its focus is on the family or the home as one setting that can interact with the developing child. It is acknowledged that the process is complicated, happening on many levels and influenced by different systems. Blaming the individual for being overweight or obese was once acknowledged. Part of the food industry still uses this perspective to justify promoting unhealthy products claiming that the consumers should have freedom of choice, as

pointed out in a commentary (Kim & Popkin, 2006). This can be seen as a part of the obesogenic environment in which children are raised. Now it is finally acknowledged that stigmatisation of obese individuals is not a beneficial public health tool for reducing obesity, but instead threatens health (Puhl & Heuer, 2010). Instead, moving past the victim-blaming approach by addressing weight stigma in interventions and initiating social changes by large-scale coordinated policies is essential. Again, the responsibility lies within all levels, as the determinants of overweight and obesity are complicated. Parents are their children's role models when it comes to sweetened beverage consumption as is confirmed in Paper I. Furthermore, they are important gatekeepers for young children; by decisively limiting their children's exposure to commercial TV, the likelihood of more frequent consumption of sweetened beverages was lower, as the results of Paper I showed. This could also be important when it comes to body image, as it has been pointed out that parents have a responsibility for introducing and focusing on healthful eating instead of focusing on weight or size in conversations with their children (Berge et al., 2013). Another issue not studied in this thesis, is media literacy, defined as "the ability to use, understand and create media and communications in a variety of contexts" (Ofcom, 2013). Children's media literacy is as important as other literacy, and the settings in which it is promoted are mainly the school and the home. As pointed out in the Nordicom book, *The Emerging Media Toddlers* (Souza & Cabello, 2010) it is not one without the other.

## Methodological discussion

Some methodological aspects, both limitations and strengths, should be discussed.

### **Papers I-III**

The samples in IDEFICS are not representative for each country, as they were chosen with the primary aim of selecting comparable regions for a community intervention. Dropouts may have entailed self-selection bias. The aim of our studies was not to estimate representative prevalence, and, therefore, it is not probable that the demonstrated associations are a result of selection bias. The convenience sampling might, however, explain some of the differences between centres in both prevalence and associations. According to a comparison study between Swedish IDEFICS participants with referent

children using data from Statistics Sweden population registers (Regber et al., 2013), there was a greater participation of families with more advantageous socio-demographic backgrounds in the IDEFICS Sweden study; families with low education and income were underrepresented in the IDEFICS Sweden study. Furthermore, obesity development was significantly larger among referents. However, BMI at inclusion had no selection effect.

IDEFICS is a prospective cohort study with an embedded intervention. The possible effects of the community intervention were not the focus of this thesis. It would have been possible to only include children from the control groups in the sample for the longitudinal analyses in Paper I and Paper II. This would, however, have decreased the sample size and thus the statistical power. Instead, the possible intervention effects were taken into account by adjusting for the intervention in all prospective analyses. Furthermore, a sensitivity analysis in a subsample including only control subjects was performed for Paper II. This resulted in weaker associations than in the full sample; however, it did not change the conclusions. This was found to improve the comparability of cross-sectional and prospective samples in addition to optimising sample size.

TV viewing indicators were linked to increased likelihood of overweight in cross-sectional (Papers II and III) and longitudinal associations (Paper II). BMI and waist to height ratio were used as indicators of overweight in Paper II. Few studies examining similar associations as studied here have used WHtR as an anthropometric measure; more common measures are BMI, BMI z-score or percentage body fat. Recent literature recommends WHtR as an anthropometric measure (McCarthy & Ashwell, 2006; Yan et al., 2007), because high central obesity (captured with waist circumference) has been associated with increased risk of developing cardiovascular diseases (Nambiar, Truby, Hughes, & Davies, 2012). Literature on using WHtR as a measure for the youngest children is scarce. Deciding the role of growth in the associations is difficult and this was taken into consideration by performing analyses in separate age groups (Paper II). Both BMI and WHtR were considered reliable measures that complemented each other in the analyses, especially because the children who were in the highest quintile group in one measurement were not exactly the same as in the other, e.g. 64% of those within the highest quintile of relative change in WHtR, were also within the highest quintile of relative change in BMI. Using more than one indicator for body weight was thus found to strengthen the results. Waist to height ratio as a measurement

estimating fat mass was not among the measurements compared in the IDEFICS validation study (Bammann et al., 2013) but has been used in published (Formisano et al., 2013; Tognon et al., 2013) and forthcoming papers within IDEFICS. An example is a recent study, which uses WHtR as one of four anthropometric measures, and concludes that adherence to a Mediterranean-like diet protects against increases in BMI, WHtR, waist circumference and per cent fat mass (Tognon et al., 2013).

Dietary and other assessment might be imprecise or subject to social desirability bias. All dietary intake and lifestyle behaviour is parent-reported and parents might be influenced by a desire to report healthy habits regarding both screen use and food. It could also have been difficult for parents to estimate their children's screen habits. This might have been the case when exposure to commercial TV was measured (Paper I), as parents reporting no exposure to commercial TV might not have been aware of their children switching channels from public service channels. Even so, a significant association between commercial TV exposure and sweetened beverage consumption was observed in the sample, despite reports of low frequency of sweetened beverage intake and TV viewing.

The questionnaire for Paper I only measured one parent's norms, i.e. how often the parent who filled in the questionnaire consumed sweetened beverages (descriptive norm), and his or her approval of the child's sweetened beverage consumption (injunctive norm). In most cases, it was the mother who completed the questionnaire. The answers to the questions were considered valid for the norms present in the family, not least since the answerer was in some cases solely responsible for the child (single parent). Recent research from Europe has furthermore shown that mothers have been found to spend significantly more time than fathers in direct interactions with their children (Scaglioni, Salvioni, & Galimberti, 2008), and that maternal food intake has been significantly associated with preschool children's food intake of all types (McGowan et al., 2012). Whether that is the case in Sweden remains outside of this discussion. It is, moreover, important to stress that the variable, *parental norms on sweetened beverages* and in some cases shortened to *parental norms*, was not intended to capture general norms of the parents in the family. However, this variable was found to indicate a valid measurement for one parent's "norms" for sweetened beverage consumption as strong associations with the children's sweetened beverage consumption were found. The assumption that an association between two variables is independent of



the third variable is important to be able to speculate further on that association. Our results suggest that parents' attitudes towards, or their own consumption of sweetened beverages does not seem to affect the association between TV viewing and more frequent sweetened beverage consumption of the children. The associations between the TV variables and the sweetened beverage consumption were robust. As the possibly confounding variable in this case, parental norms on sweetened beverages, was associated with the dependent variable, speculations can continue on causal relations. The fact that the confounding variable did not affect the association even though it affects the dependent variable does it more likely that TV viewing affects the dependent variable.

Different variables for both screen use and sweetened beverages were used in the different papers and this might confuse the reader. In Paper I, sweetened beverages were combined from artificially (ASB) and sugar-sweetened (SSB) beverages. In Paper II, only SSB consumption was measured. ASB and SSB were combined to limit the risk of possible bias based on the answers falling in the wrong category because of the examples given in the Swedish questionnaire. When analysed separately, the associations with SSB consumption were, however, similar to associations with the combined. In Paper III SSBs were a part of the high-sugar propensity. In Paper I the variables for screen use were various, as the Swedish questionnaire included questions on commercial TV exposure developed for this thesis. The standard questions on TV and total screen time were used in Paper I and II, and in Paper III the questions on TV in the bedroom and TV during meals were added in association with high-sugar and high-fat propensity. The variables for TV viewing and total screen time were treated as continuous in Papers I and II, for example to clarify and facilitate the use of odds ratios for each hour per day, instead of giving odds ratios for each interval from the original ordinal scale in the questionnaire. In spite of the diversity in variables, they are all related and are indicators of the lifestyle being examined. How does screen use relate to food habits and anthropometry? This might be considered strength, as the results do not seem to depend on how the variables are built.

The strengths of the IDEFICS study are its multicentre approach with different European countries being represented. Also the large data set providing statistical power, internationally standardised design and methodology. The studies in this thesis are strengthened by each other and

provide conclusions based on cross-sectional and longitudinal analyses of several important variables.

### **Paper IV**

Paper IV focused on TV content besides advertisements, i.e. examining how food was presented in children's TV programmes in Sweden. Different levels of analyses were considered for the study described in Paper IV. The coding instrument and methods were carefully developed in cooperation between the authors. In a pilot study, food appearances were coded on the basis of programme section after excluding coding on the basis of scene or by time unit (e.g., per minute, five minutes, ten minutes or half an hour). These options were excluded, as they were not found reliable. Estimating a scene proved to be difficult to do objectively, and to code by time unit was not reliable since certain foods would have been overrepresented. After testing and discussing uncertain cases, coding food appearances on the basis of each programme section was found to be the most reliable, as the definition of a programme section was non-negotiable. The coding process was pilot tested and discussed and rehearsed by the authors of Paper IV. Analysis of inter-rater reliability revealed 93% agreement in regard to food appearances.

The strengths of the study in Paper IV were its novelty in a Swedish context as well as the Swedish circumstances with a public service, commercial-free channel for children. It can be assumed that a majority of Swedish children in the age group from two to nine years old at some time watch the show that was studied (MMS, 2012; Swedish Media Council, 2013). Moreover, the sample covers material aired over a period of nearly five months and probably represents a variety of programme content.

# Conclusions

The results indicate that:

- Young children's screen time is associated with increased body weight and central obesity:
  - Watching TV and screens at baseline predicted most relative increase in BMI and waist to height ratio.
- Young children's screen time (especially TV viewing) is associated with intake of sugary foods:
  - TV time (watching more than 60 min/day and having TV in the bedroom) is associated with consumption of high-fat and high-sugar foods.
  - The more time children spend watching TV and in front of screens, the greater the likelihood of consuming sweetened beverages more frequently.
  - Parental norms regarding sweetened beverages do not seem to explain the association between screen time and consumption of sweetened beverages.
- These associations seem to be explained by exposure to commercials and other TV content as well as eating while watching TV:
  - Consumption of high-fat and high-sugar foods is associated with eating while watching TV.
  - Exposure to commercial TV is associated with more frequent consumption of sweetened beverages.
  - Parents' attempts to limit children's exposure to TV commercials seem to be important in order to decrease the children's consumption of sweetened beverages.
- Food and beverages frequently appear in children's TV programmes in Sweden. A health promoting perspective seems to be taken in some aspects. However, high-calorie and low-nutrient foods (HCLN) are also promoted:
  - HCLN foods more often appear with children than adults in films and cartoons while fruits and vegetables more often appear with adults.
  - HCLN foods more often appear actively handled while fruits and vegetables more often appear in the background.



## Implications

The conclusions from this thesis can contribute several insights for public health and public service television. Firstly, this thesis contributes by shedding light on how food appears in children's TV programmes, by which the audience's food habits might be influenced. A health promoting perspective could be taken more often within children's TV programme production. Healthy foods were portrayed in many ways in the Swedish production of the studio sections. In other programme sections, sugary foods were also prominent, leaving potential for promoting healthier alternatives.

The second contribution of this thesis is acknowledging television's role in developing unhealthy food habits or overweight and explaining some of the possible pathways: through total TV time, exposure to commercials and other content, and through eating while viewing. Our findings suggest that TV is still an important part of the time young children spend in front of screens and TV still seems to have a stronger effect than other screen activities. However, the relations between children's food habits, screen use and weight status are complex, intertwined and happening on many levels.

This thesis has focused on young children, their lifestyle and health. Children's food habits are of interest for public health as establishing healthy food habits at a young age is important for future health. The results of this thesis cannot confirm a possible decrease in SSB consumption, except to the extent of stating that a minority of the sample increased their SSB consumption during the IDEFICS study. The results of this thesis do not either reflect the on going shift from traditional television viewing towards mobile screens where the programme is set by each viewer. In light of that, it is important to include the content of online content available to young children in future research on the possible effects of screens on children.

The importance of parents as gatekeepers should not be underestimated. The third contribution of this thesis is strengthening of the assumption that it is possible to affect children's food habits by influencing their TV habits, as parents' attempts to limit children's exposure to TV commercials were found to be important. This happens in the family setting where the parents have the strongest saying. Eliminating television is, however, not the goal. Television's positive sides as an educational, relaxing pastime should not be overlooked. Children grow up

with TV and other screen media from infancy. Developing their media literacy is one of the parents' tasks in cooperation with the school system.

It is argued that the responsibility for children's food habits is not solely that of the parents' as parental norms on sweetened beverage consumption were observed not to affect the association between TV viewing and sweetened beverage consumption. The fourth important result contributing to public health is that community action is needed. In other words, parents cannot easily control the obesogenic environment. This is consistent with a recent paper from Sweden concluding that a supporting community is essential for parents to be able to support their children in establishing healthy habits (Magnusson, Berg, & Mårild, 2013), and in line with Marmot and colleagues (Marmot, Friel, Bell, Houweling, & Taylor, 2008) who state that action on the social determinants of health must involve all sectors of society. Involving all systems of society is necessary as TV viewing itself may be happening within the immediate context of the child, while the TV content broadcast is a part of the larger society.

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# Appendix

## **Statement accounting for my individual contribution to the research**

Under the guidance of my supervisors, my contribution to the research work was as follows:

### Publication I:

- Contribution to the design of the study
- All statistical analyses and interpretation of the data
- Writing the article
- Revision of the manuscript according to the reviewers comments

### Publication II:

- Contribution to the design of the study
- All statistical analyses and interpretation of the data
- Writing the article
- Revision of the manuscript according to the reviewers comments

### Publication III:

- Searching and summarizing relevant literature for the introduction
- Commenting on analyses and drafts of the paper

### Publication IV:

- Designing the study
- Data gathering
- Coding data
- All statistical analyses and interpretation of the data
- Writing the article

PhD candidate: Steingerdur Olafsdottir

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Gabriele Eiben