Enhancing Healthy Lifestyles

An Analysis of Factors Influencing Diets of European Children

Gwozdz, Wencke; Reisch, Lucia; De Henauw, Stefaan ; Lissner, Lauren; Moreno, Luis; Tonaritis, Michael ; Molnar, Denes ; Siani, Alfonso; Veidebaum, Toomas; Pigeot, Iris

Enhancing healthy lifestyles:
An analysis of factors influencing diets of European children*

Wencke Gwozdz[1], Lucia A. Reisch[1], Stefaan DeHenauw[2], Lauren Lissner[3], Luis Moreno[4], Michael Tornaritis[5], Denes Molnar[6], Alfonso Siani[7], Toomas Veidebaum[8], Iris Pigeot[9] - On behalf of the IDEFICS Consortium

Copenhagen Business School, Denmark[1];
Department of Public Health, Faculty of Medicine and Health Sciences, University Hospital, Ghent University, Ghent, Belgium[2];
Department of Public Health and Community Medicine, Public Health Epidemiology Unit, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden[3];
Growth, Exercise, Nutrition and Development Research Group, University of Zaragoza, Zaragoza, Spain[4];
Research and Education Institute of Child Health, Strovolos, Cyprus[5];
Department of Paediatrics, Medical Faculty, University of Pécs, Pécs, Hungary[6];
Institute of Food Science & Technology, National Research Council, Italy[7];
National Institute for Health Development, Tallinn, Estonia[8];
Bremen Institute for Prevention Research and Social Medicine, University of Bremen, Bremen, Germany[9]

Contact details:

Wencke Gwozdz
Copenhagen Business School
Porcelænshaven 18A
2000 Frederiksberg
Denmark

e-mail: wg.ikl@cbs.dk
telephone: 0045 3815 3391

---

* This study was carried out using IDEFICS study data from 2007/2008.

Corresponding author: Wencke Gwozdz,

Abstract

Because interventions related to diet and other health behaviours are seldom successful and/or sustainable, it is extremely important to identify the individual factors that contribute to a healthier or unhealthier diet. To this end, we use cross-sectional data from the IDEFICS study to analyse the dietary behaviour of children aged between 2 and 9 years in eight European countries. We model the complex nature of these individual factors using structural equation modelling. Our results show that both sedentary behaviour and food exposure are strong contributors to children's dietary choices. However, although we find a positive relation between a healthy diet and weight status for girls, weight status appears independent of diet quality for boys. These outcomes, although they permit no firm conclusions on health policy strategies, clearly suggest that further research based on longitudinal data could provide valuable insights for the design of successful prevention and intervention strategies.

JEL-Classification: D12, I1; P46

Keywords: Children; diet; healthy eating; weight status; Europe; individual factors

Enhancing healthy lifestyles:
An analysis of factors influencing diets of European children

1. Introduction

Knowledge about health-supporting lifestyle factors and behavioural strategies does not, in itself, keep individuals from adopting unhealthy lifestyles: both behavioural and neurocognitive consumer research shows that even well-informed adults do not predominantly or generally follow their stated/long-term preferences in a rationally self-controlled and disciplined manner. In fact, humans tend to discount future well-being hyperbolically and have a strong preference for the “now”. In other words, although ill-health consequences can manifest themselves in the long term, most individuals prefer the present over the future (Scharff, 2009). Moreover, habits, emotions, and the immediate choice context – the affordability, availability, and accessibility of healthy food and/or opportunities for physical activity – strongly influence consumer decisions and easily override such cognitive factors as attitudes and good intentions (Thaler and Sunstein, 2008).

If the above observations hold true for adults, then children between the ages of 2 and 9 cannot be held responsible for their own dietary choices. Rather, these children depend on the stimuli and contexts provided by their socialization environment (Roedder John, 2008). Hence, for this age group, parents and educators serve as the primary gatekeepers for the availability and accessibility of food. Nevertheless, the parents’ ability to provide health supporting diets may also be limited, particularly in families with lower socio-economic status, who live in “food deserts” and have limited food choices.

Current health models draw heavily on theories of socialization (Roedder John, 2008) and social learning (Bandura, 1977), which stress that children learn behavioural patterns from role models and through the observation of their own social and cultural environments (Sellers et al., 2005). Some scholars also combine social learning theory with social ecological theory in order to classify the numerous environmental factors that affect children’s health behaviour (Bronfenbrenner, 1989). The resulting human ecological models (e.g., Popkin, 2005, Story, Neumark-Sztainer, and French, 2002, Story et al., 2008) use hierarchical arrangements to systemize the complexity of the numerous factors affecting health behaviour. However, although the British Foresight (2007) project identified 108 factors influencing children's health behaviour and several other studies have emphasized their numerosity and the complexity of their poorly understood interactions (e.g., Kumanyika et al., 2002, Procter, 2007, Reilly, 2007, Story et al., 2008), no consensus has emerged on the number of factors involved or on their absolute and relative effects on children's diet and body weight. This lack of knowledge contributes to the observed phenomenon of "resistance to intervention", in which strategies to nudge children into healthier lifestyles are often less effective and less sustainable than expected. Research is therefore needed to uncover the relations among health behaviour factors and their relative impacts (Foresight, 2007).

To this end, this study analyses select individual factors – biological, social-psychological, and lifestyle – that influence children's diet and explores their associations with health outcomes, particularly weight status. To do so, we draw on the unique IDEFICS data set, which covers over 16,000 children in eight countries (Italy, Cyprus, Spain, Hungary, Estonia, Sweden, Belgium, and Germany). Our contribution is twofold: (a) our study is, to our knowledge, the first European study on this topic that encompasses eight countries and (b) we have at our disposal an extraordinarily rich data set containing elaborate information on the individual factors of diet and obesity.

The paper proceeds as follows: Section 2 reviews the relevant research on the topic, section 3 describes our data and methodology, section 4 discusses the study results and section 5 summarizes our findings.

2. Previous research

The imbalance between diet and physical activity affects all health outcomes but particularly future body weight: over a protracted time span, even a small positive energy balance can result in overweight or even obesity. Yet to date, the evidence on the association between diet and obesity is inconclusive, with both longitudinal and cross-sectional studies reporting controversial results (Craig et al., 2010, Moreno and Rodriguez, 2007, Reilly et al., 2005, Veugelers and Fitzgerald, 2005). At minimum, there is agreement on the current dietary recommendations of high fruit and vegetable intake and low sugar and (trans)fat consumption (Ells et al., 2008).

Diet, however, is shaped not only by environmental factors but also by individual factors like biological predisposition (e.g., hunger and sensory preferences), social-psychological factors (particularly emotional well-being, self-esteem, and stress resistance) and lifestyle factors (e.g., meal patterns and media use). These factor bundles all influence dietary choices and are thus potential drivers for overweight and obesity (Reisch, Gwozdz, and Beckmann, 2011). At the same time, they also co-determine the receptiveness to intervention activities (EUFIC, 2005).

Biological factors

The primary biological factors that influence diet are genetics, appetite control (EUFIC, 2005), and taste preferences (Dr. Rainer Wild-Stiftung, 2008). Although their influence on children's dietary choice is not yet fully understood, these biological predispositions may affect diet habits and weight through appetite, fat storage, or taste preferences (National Health Service, 2008). Such biological programming, it is widely accepted, takes place during pregnancy and infancy (Robertson, Lobstein, and Knai, 2007), meaning that early life factors can serve as indicators for biological factors. For example, one review of 61 studies shows that breastfeeding is more strongly associated with lower risks of obesity than formula feeding (Owen et al., 2005). This lower risk could result from two mechanisms: a biological predisposition indicator – overweight and obese mothers tend to breastfeed their children for a shorter period; and a taste preferences indicator – children to some extent taste the mother's diet through breast milk (Leathwood and Maier, 2005). These early experiences set the stage for later dietary habits (Beauchamp and Menella, 2009). Maternal smoking during pregnancy is also related to unhealthier diets and higher risks of obesity later in life (Mamun et al, 2006, Power and Jefferis, 2002, Toschke et al., 2003, von Kries et al., 2002), possibly because it affects appetite control and thus dietary habits and weight status (Kane et al., 2000, Slotkin, 1998). However, the concrete mechanisms of this influence are not yet fully understood.

Social-psychological factors

Another likely influence on children's diets and weight status are social-psychological factors, whose most important indicators in children are emotional well-being, self-esteem, and personality type. In children particularly, lower levels of self-esteem and well-being have been linked to higher rates of sadness, loneliness, and nervousness and a higher probability of engaging in risky behaviours such as eating disorders (Ferrante et al., 2010; Shea and Pritchard, 2007; Strauss 2000; Tiggemann, 2005). Children who are stressed, sad, nervous, or anxious also tend to exhibit either increased or decreased appetite (Wardle, 2007). If appetite increases, food can be used to compensate or stimulate, thereby changing an individual's mood (Belk, 1975), as in the case of the so-called "comfort foods", which are often high in fat, sugar, or salt, and are recognized to be relatively unhealthy (Darnton, 2009). These "comfort foods", it seems, are easier to digest than other foods when an individual is in an unstable emotional state (Butress, 2004). On the other hand, children in a stable emotional state recover faster from setbacks, implying that more self-confident children are less likely to depend on "comfort food". This assumption in turn implies that diet should be positively influenced by self-esteem. In fact, the literature does include some research on the effects of obesity on self-esteem and emotional well-being; however, the primary focus of these studies is the stigmatization of obese children, which then leads to even lower levels of self-esteem and well-being (French, Story, and Perry, 1995, Latner and Stunkard, 2003).

Lifestyle factors

Lifestyle factors such as eating patterns, sedentary behaviour, and leisure time activities like playing, sports, television viewing, or playing computer games are strongly related to diet and obesity (Jago et al., 2005, Janssen et al., 2005, Trost et al., 2003) and are recognized as a risk factor for obesity (Procter, 2007, Robertson, Lobstein, and Knai, 2007). One of the most analysed and discussed leisure activities with obesity risk (Darnton, 2009) is television viewing, which is often accompanied by a variety of unhealthy behavioural patterns. For example, it might displace physical activity, can be accompanied by snacking, and can increase a viewer's exposure to food advertising. However, longitudinal support for the complementarity of physical activity and television viewing is scarce

(Epstein et al., 2005, Taveras et al., 2006), and cross-sectional evidence shows a weak association (Epstein et al., 2005, Kaiser Family Foundation, 2004). A number of studies have investigated the effect of physical activity and television viewing on diet and body weight (e.g., Desroches and Holt, 2007, Hastings, 2003, Livingstone, 2006), but findings are mixed. Nevertheless, about 20–25% of children's daily energy intake occurs through snacking in front of the television (Matheson et al., 2004). Media also have the power to influence eating habits by impeding the development of eating habituations and interrupting the habituation to food cues (Temple et al., 2007), which is regulated by biological signals from the sensory, neuronal, and digestive systems (Swithers and Hall, 1994). Food advertising specifically makes use of emotional stimuli; that is, it aims at emotional conditioning through repeated exposure to a positive atmosphere in combination with a product (Phelps, 2006).

Familiarity is another important lifestyle factor that shapes not only food preferences but also actual diet. The "familiarity effect" occurs when food exposure affects food preferences and food choices (Wardle, 2007), and habits are created through exposure, repetition, and rewarding behaviours. It is therefore logical to expect that changes in the food environment will affect children's dietary patterns. Such changes over the past three decades have included a strong growth in convenience foods (Jeffery and Utter, 2003), increased portion sizes (Diliberti et al., 2004), and more processed foods offered in supermarkets, meaning easier access to them (Reisch, Gwozdz, and Beckmann, 2011). Not only are these convenience and highly processed foods low in nutritional value (despite often being energy dense), but many consumers have difficulty assessing their dietary quality (Procter, 2007). Therefore, children who are exposed primarily to highly processed, ready-made food can be expected to have unhealthier diets than children who are regularly exposed to fresh foods. In fact, experiments have shown that mere exposure to healthy foods increases its intake (Baranowski et al., 1993, Gillman et al., 2000), and there is empirical evidence of a strong association between high fruit and vegetable consumption by parents and high fruit and vegetable consumption by their children (Cooke et al., 2003, Wardle, Carnell, and Cooke, 2005). Thus, familiarity with healthier or unhealthier foods seems to shape not only children's taste preferences but also their habits and consequently their diets.

In sum, on an individual level, biological, social-psychological, and lifestyle factors all seem to influence children’s diet and weight status. Yet, to our knowledge, the present study is the first to investigate the effects of these numerous individual factors *simultaneously*. Such simultaneous investigation is extremely important, not only because the effects may vanish or become stronger once many other factors are controlled for, but because it allows determination of the relative importance of these factors.

3. Data and Methods

3.1. Data

The data used in this study are taken from the IDEFICS study (“IDentification and prevention of dietary and lifestyle induced health EFfectsIn Children and infantS”), which is supported by the Sixth Framework Program of the European Commission and uses standardized data collection methods in all survey countries (Ahrens et al., 2011). In each of the eight survey countries – Italy, Cyprus, Spain, Hungary, Estonia, Sweden, Belgium, and Germany – two regions were selected: one intervention and one control region. Both regions were chosen through population-based sampling, which resulted in a non-representative but comparative sample. It must therefore be stressed that the data collected in the individual regions are not representative of their countries as a whole.

Participants were recruited via their daycare centers or schools. The data collection, carried out between September 2007 and June 2008, included a detailed parental questionnaire in which parents described their children’s lifestyle, diets, consumer behavior, and socio-demographic circumstances. A thorough physical examination was also conducted of all children in the sample to determine their weight status and other cardiometabolic health indicators. The response rate was 53.5%, resulting in a sample of 16,223 children aged between 2 and 9 years. The examination was repeated two years later after half the participants had undergone interventions promoting healthy lifestyles. The present study, however, is limited to the baseline data collected prior to these interventions. The inclusion criterion is the availability of complete information on weight, height, age, and sex.

3.2. Structural equation modelling

We model the biological, social-psychological, and lifestyle factors using structural equation modeling (SEM), which enables some level of control over the complexity of the diverse individual factors influencing children's diet. Specifically, we implement the non-parametric partial least squares (PLS) model developed by Wold (1982, 1985), whose minimal requirements for residual distributions and measurement scales make it very robust. This model, in contrast to the covariance SEM models, uses a variance-based iterative approach based on multivariate regressions that employ the least-squares algorithm (Fornell and Cha, 1994). The standard errors are calculated via a bootstrap re-sampling procedure (Efron and Tibshirani, 1993). The structural equation modelling employs two different model types: (a) a structural model that mirrors the theory-driven hypotheses and (b) measurement models that describe the operationalization of each concept. Such operationalization may be either reflective – the variables act as indicators for a concept (i.e., factor analysis) – or formative – the variables explain a concept (i.e., regression analysis).

The quality of the structural and measurement models is evaluated using separate criteria. Because *structural model*s are non-parametric, no inferential test statistics are available. However, the determination coefficient (R^2) of the dependent construct is equivalent to those seen in traditional regression analyses. Likewise, the path coefficients are equivalent to the standardized coefficients in a traditional regression analysis. The coefficient *t*-statistics are computed by bootstrapping, which treats the original sample as the population and draws (in our case) 200 sub-samples (sample size = original sample size). This re-sampling leads to robust standard errors that are again used to calculate *t*-statistics and significance levels (Tenenhaus et al., 2005). The reliability of the *measurement models* is ascertainable using Cronbach's alpha or composite reliability. Unlike the case for constructs, which should be eliminated when the values are below 0.4, both these values are good when above 0.7 (Bagozzi and Baumgärtner, 1994). In testing for convergent validity, the average variance extracted (AVE) should be at least 0.5 (Homburg and Giering, 1996). Additionally, the factor loading from each manifest variable on its construct must be higher than 0.4, which also calls for high positive correlation between variables.

3.3. Structural model

First, we estimate the effects of the biological, social-psychological, and lifestyle factors on children's diet. Our model therefore looks as follows:

$$D_i = \beta_0 + \beta_1 B + \beta_2 S + \beta_3 L + \beta_4 C + \varepsilon_i \qquad (1)$$

where *D* denotes children's diet, *B* is a matrix of constructs measuring biological factors, *S* is a matrix of social-psychological factors, and *L* is a matrix of lifestyle factors. *C* describes a set of control variables, and the βs are standardized regression coefficients. The model is estimated for both the total sample and for a sample stratified by sex.

In a second step, we estimate an extended model based on the theoretical assumptions that (a) individual factors explain diet and (b) diet as a proxy of health behaviour is related to children's weight status. The result is the following model:

$$W_i = \beta_0 + \beta_1 D + \beta_4 C + \varepsilon_i \qquad (2)$$

where *W* denotes the children's weight status explained through diet, measured as the matrix *D* and control set *C*. Formula (1) is implemented to explain *D*, meaning that there are two endogenous constructs in the model: diet and weight status. All models are estimated for both the total and stratified sample.

3.4. Measurement models

In the following description of how we operationalize the model's constructs as manifest variables, all constructs are measured reflectively (i.e., as indicators of the construct) unless otherwise indicated. Our analysis uses two dependent variables: the "healthiness" of the children's diet and children's weight status. Figure 1 presents model (1) and (2) – including the measured concepts which are presented in the following.

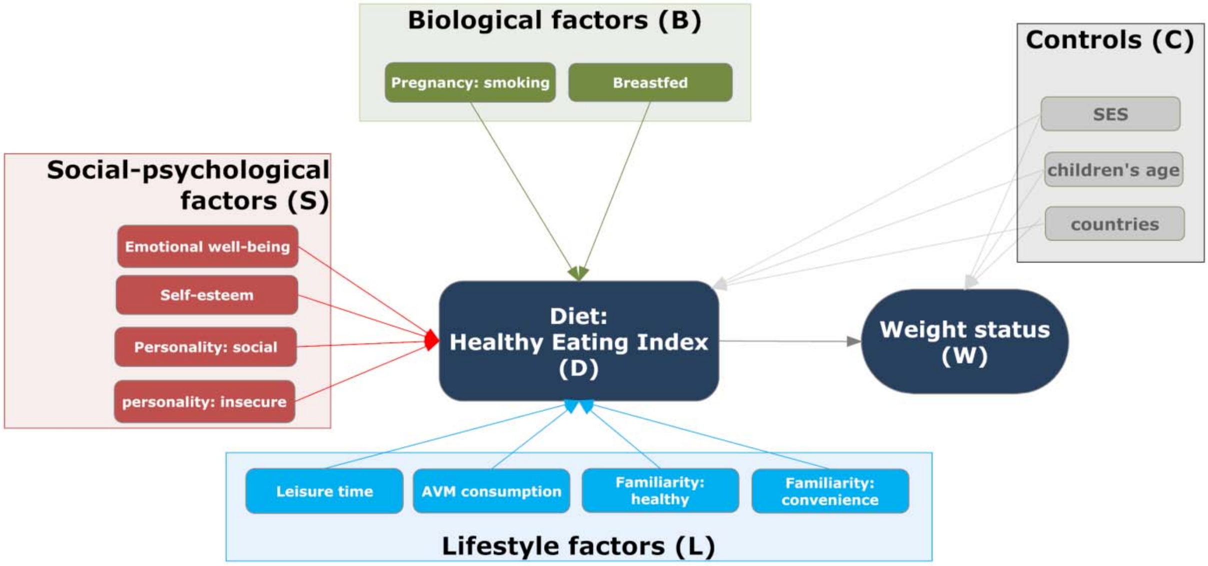

Figure 1: An overview of the structural models (1) and (2)

3.4.1. Children's diet

The first dependent variable – children's diet – is a continuous variable that describes diet on the Youth Healthy Eating Index (YHEI) (Feskanich et al., 2004), which ranges from 0 to 90, with a higher score signalling a healthier diet. We employ this index, which in fact measures adherence to U.S. dietary guidelines, because there is no corresponding index for European children nor even common European guidelines on which to base such an index. The U.S. index is therefore the best available instrument for generating comparable data among the eight survey countries and drawing conclusions on the relative healthiness of a diet.

The YHEI, which measures food consumption and food-related behavioural patterns, is based on food frequencies, collected in the IDEFICS survey using the Children's Eating Habits Questionnaire (CEHQ) (Lanfer et al., 2011), a screening tool for the food frequencies and food patterns usually associated with health in children. For the IDEFICS study, parents indicated their children's food consumption of 43 food categories in a typical week during a four-week period. Based on the CEHQ, it was possible to replicate 11 of the original 13 dimensions of the original YHEI and thereby develop an index adapted to the European setting. The YHEI includes the following frequency dimensions, whose intentions are given in brackets:

1. ‘Whole grains’ (sources of fibre, vitamins, and minerals),
2. ‘Vegetables’ (five a day),
3. ‘Fruits’ (five a day),
4. ‘Dairy’ (sources of calcium),
5. ‘Meat ratio’ (sources of protein),
6. ‘Snack foods’ (unnecessary energy),
7. ‘Soda and drinks’(unnecessary energy), and
8. ‘Margarine and butter’ (sources of saturated fat).

The food behavioural pattern dimensions are as follows:

9. ‘Fried foods outside home’ (high energy intake),
10. ‘Eat breakfast’(indicator of healthful dietary patterns), and
11. ‘Dinner with the family’ (indicator of healthful dietary patterns).

We had no data on the dimensions ‘multivitamin use’ and ‘visible animal fat’.

To calculate the YHEI, we use the sum of all available sub-scores, the criteria for which are adapted from Feskanich et al. (2004) and presented in Table 1. The possible minimum for the YHEI is 0 and the maximum is 90. We compute the overall index for children using all the dimensions included in the CEHQ, which results in almost a bisection of the sample (*n* = 7,453). We therefore impute means by age, sex, and country for children for whom a maximum of one or two dimensions are missing. Because of this imputation, the total sample comprises 13,622 cases.

To validate the index, we discussed it with dieticians from the IDEFICS study and compared their input with the original index of Feskanich and colleagues (2004). Despite some shortcomings (the two missing dimensions, not the lack of European guidelines), we concluded that the index is a useful proxy for the healthiness of children’s diets.

	YHEI scoring criteria	
YHEI dimensions	**Requirements for max. score of 10**	**Requirements for min. score of 0**
	← Servings per day	→
1. Whole grain	≥ 2	0
2. Vegetables	≥ 3	0
3. Fruits	≥ 3	0
4. Dairy	≥ 3	0

5. Meat ratio	≥ 2	0
6. Snack foods	0	≥ 3
7. Soda & drinks	0	≥ 3

	Requirements for max. score of 5	**Requirements for min. score of 0**
8. Margarine & butter	Daily	≥ 2 pats/day
9. Fried foods outside home	Never	Daily
10. Eat breakfast	≥ 5 times/week	Never
11. Dinner with the family	Daily	Never

Table 1: Youth Healthy Eating Index (YHEI) scoring criteria, based on Feskanich et al., (2004)

3.4.2. Children's weight status

In a second step, we estimate the effect of diet on children's weight status using three different models, each based on a different dependent variable: BMI, overweight/obese, and obese. In the first model, the dependent variable is a continuous variable describing BMI as a percentage of the distribution function based on the growth charts put out by the Center for Disease Control and Prevention (CDC) (Kuczmarski, Ogden, and Guo, 2002). These CDC growth charts were defined based on national U.S. data collected between 1963 and 1994. Stratified by age and sex, the two BMI cut-off values on the distribution are 85% and 95%. The 85th to the 95th percentile is designated "overweight" and the 95th percentile onward, "obese". The second model then includes the dependent variable "overweight/obese" in the form of a dummy (1 = 85th percentile or above), and the third model contains the dependent variable "obese", also as a dummy (1 = 95th percentile or above).

3.4.3. Individual factors

We operationalize the diverse constructs within each of the three individual factors – biological, social-psychological, and lifestyle – deriving all variables used from the parental questionnaires. The measures used for each dimension are presented as descriptive statistics in Appendix A1. Dimension measurement was performed only after careful consideration of the theoretical approaches, previous research, and data availability, and, as suggested by Bollen (2000), variables that did not contribute to a valid and reliable measurement were deleted. All the resulting measurement models, therefore, adhere to the quality criteria (cf. Section 3.1: Structural equation modelling).

Biological factors

For the biological factors, we measure two constructs: breastfeeding and smoking during pregnancy. The former, modelled formatively to describe only breastfeeding, is a dummy variable indicating whether the child was breastfed or not. The latter is also modelled as a dummy variable that indicates whether or not the mother smoked during pregnancy (yes/no).

Social-psychological factors

For the social-psychological factors, our model includes four constructs: one for emotional well-being, one for self-esteem, and two for children's personality. The construct of emotional well-being is measured by the following items: a) *"During the last week my child did not feel much like doing anything"*, b) *"During the last week my child felt lonely"*, and c) *"During the last week my child was insecure or anxious"*. The answer categories range from 0 'not at all' to 3 'often or always'. Thus, higher construct values mean lower emotional well-being.

Self-esteem is operationalized by the following questions: a) *"During the last week my child was proud of him/herself"*, b) *"During the last week my child felt on top of the world"*, and c) *"During the last week my child had many good ideas"*. The answer categories again range from 0 'not at all' to 3 'often or always'. Hence, higher construct values mean more self-esteem.

To measure a child's personality, we employ two constructs – insecure personality and social personality. An insecure personality is measured based on parental agreement with two statements about their child's characteristics: a) *"Nervous or clingy in new situations, easily loses confidence"* and b) *"Has many fears, is easily scared"*. A social personality is measured by parental agreement with three statements: a) *"Considerate of other people's feelings"*, b) *"Shares readily with other children (toys, etc.)"*, and c) *"Often volunteers to help others"*. The scaling ranges from 0 'not true' to 2 'certainly true'. Higher construct values mean either a more insecure or a more social personality.

Lifestyle factors

For lifestyle factors, we operationalize four constructs: one for leisure time, one for audio-visual media (AVM) consumption, and two for familiarity with foods. The leisure time indicators – physical activity and leisure time activity – are both continuous variables measured in hours per week. Physical activity is based on parental reports of the hours and minutes their children spend playing outdoors on a typical weekday or weekend day and/or at a sports club per week. Leisure activities are measured based on parental reports of the hours and minutes their children spend playing in the yard or street around the house or at a park, playground, or outdoor recreation area.

AVM time, the children's total screen time, is measured by the average hours children spend on weekdays and weekends watching television, video, and/or DVD, or in front of a computer or a game console. The higher the construct values, the more AVM time.

Children's familiarity with foods at home is measured by two constructs: familiarity with healthier foods and exposure to convenience food. Familiarity is measured based on parental evaluations of three statements: a) *"I compare labels to select the most nutritious food"*, b) *"I try to avoid food products with additives"*, and c) *"I make a point of using natural or ecological food products"*. Exposure to convenience food is measured based on their evaluations of two statements: a) *"We use a lot of ready-to-eat foods in our household"* and b) *"I use a lot of mixes, for instance baking mixes and powdered soups"*. The answer categories for all variables range from 1 'disagree' to 5 'agree'. Hence, the higher construct values indicate higher exposure to either healthier foods or convenience foods.

Control variables

The controls encompass three constructs: child's age, socio-economic status, and survey country. Child's age, measured formatively, is assessed using dummy variables, one for each year. Socio-economic status is indicated by the education (ISCED level) of the mothers and fathers, as well as net household income, which is classified into nine categories. To derive comparable income categories by country, we base the country-specific categories on country-specific median income for a household consisting of two adults and one child. The lowest category is defined by each country's poverty line for a single parent with one child. The last construct, survey country, consists of country dummies, and, like child's age, it is measured formatively.

Table 2 provides an overview of all measurement models.

Construct	Manifest variables
BMI CDC	a) BMI (in percent of CDC distribution function)
Diet[1]	a) Youth Healthy Eating Index (YHEI)
	Biological factors
Breastfed	a) Breastfed (dummy)
Pregnancy: smoking	a) Smoking during pregnancy (dummy)
	Social psychological
Well-being[2]	a) During the last week my child did not feel much like doing anything b) During the last week my child felt lonely c) During the last week my child was insecure or anxious
Self-esteem[2]	a) During the last week my child was proud of him/herself b) During the last week my child felt on top of the world c) During the last week my child had many good ideas
Personality: social[3]	a) Considerate of other people's feelings b) Shares readily with other children (toys, etc.) c) Often volunteers to help others
Personality: insecure[3]	a) Nervous or clingy in new situations, easily loses confidence b) Has many fears, is easily scared
	Lifestyle
Leisure time	a) Physical activity (hours per week) b) Leisure time activities (hours per week)
Familiarity: healthy[4]	a) Compare labels to select the most nutritious food b) Try to avoid food products with additives c) Make a point of using natural or ecological food products
Familiarity: convenience[4]	a) Use a lot of ready-to-eat foods in household b) Use a lot of mixes, for instance baking mixes and powder soups
Audiovisual consumption	a) Time (hours) spent with audiovisual media on weekdays b) Time (hours) spent with audiovisual media on weekends
	Controls
Age of child (dummies)	a) 2 years – 9 years
SES parents	b) ISCED mother c) ISCED father d) Household net income (classified into 9 categories)
Country dummies	a) Belgium, Cyprus, Estonia, Germany, Hungary. Italy, Spain, and Sweden

[1]YHEIndex from 0 – 90 (the higher the value, the healthier the diet)
[2] Scale from 0 to 3 – (‘not at all’ to ‘often or always’)
[3] Scale from 0 to 2 – (‘not true’, ‘somewhat true’, ‘certainly true’)
[4] Scale from 1 to 5 – (‘disagree’ to ‘agree’)

Table 2: Measurement instruments for individual factors

4. Results

4.1. The impact of individual factors on diet

Table 3 presents the descriptive statistics on children’s diet (YHEI) by survey country and sex. The YHEI value varies – depending on country – between 47.3 and 57.4. According to these figures, children in Italy and Belgium have the unhealthiest diet and children in Sweden, by far the healthiest diet. Interestingly, barely any diet differences are observable in any country based on sex.

			By sex		
	Obs.	Total	Girls	Boys	*p* (*t*-test)
Italy	1,891	47.3	47.6	47.0	.087
Estonia	1,559	53.0	53.2	52.7	.181
Cyprus	1,357	49.2	49.0	49.3	.550
Belgium	1,620	47.8	48.8	47.3	.007**
Sweden	1,674	57.4	57.5	57.2	.431
Germany	1,766	49.2	49.1	49.3	.722
Hungary	2,375	49.1	49.2	49.1	.716
Spain	1,380	51.6	51.6	51.7	.615
All countries	12,954	50.6	50.6	50.3	.072

Legend: * p < .05, ** *p* < .01, *** *p* < .001

Table 3: Descriptive statistics for the YHEI by country and sex

Sex differences do emerge, however, for the means of the individual factors presented in Table 4, which are the unstandardized means of the constructs calculated in the first PLS model (i.e., individual diet factors). We find gender differences in both social-psychological and lifestyle factors. As regards the first, girls have higher average values on self-esteem and social personality. They are also better off than boys in terms of emotional well-being (i.e., a lower number indicates a higher well-being).

Boys also seem to be more insecure, implying that girls are more emotionally stable, at least according to parental reports. Likewise, in terms of lifestyle factors, boys are more active and engage in longer screen times, whereas girls face higher levels of exposure to healthy foods and lower levels of exposure to convenient foods. The descriptive numbers on leisure time activity and AVM time for boys and girls, however, indicate no substitution of one with the other (cf. Epstein et al., 2005, Kaiser Family Foundation, 2005). Moreover, a correlation analysis shows no relationship between leisure time activities and AVM consumption. Therefore, taking these differences into account, we also test whether leisure time activity and AVM consumption have different effects on the diets of girls versus boys.

Construct	**Girls**	**Boys**	***p* (*t*-test)**
	Biological factors		
Breastfed	.61	.62	.607
Pregnancy: smoking	.12	.13	.850
	Social-psychological factors		
Well-being	.54	.58	.014*
Self-esteem	2.57	2.52	.000***
Personality: social	1.56	1.46	.000***
Personality: insecure	.42	.48	.000***
	Lifestyle factors		
Leisure time	20.60	21.89	.000***
AVM consumption	1.65	1.84	.000***
Familiarity: healthy	3.51	3.48	.000***
Familiarity: convenience	1.56	1.62	.184
Observations	4,202	4,132	

Note: Unstandardized means of PLS constructs by sex, *p*-values for *t*-test
Legend: * $p < .05$, ** $p < .01$, *** $p < .001$

Table 4: Descriptive statistics for individual factors (construct means) by sex

The PLS results for individual factors on the YHEI are depicted in Table 5, in which the coefficients can be interpreted as standardized regression coefficients. In general, many of the factors have a significant effect (including the expected sign) on diet. For example, among the biological factors, breastfeeding is associated with a healthier diet. The effect of maternal smoking during pregnancy, however, is not significant, a finding that contrasts starkly with Mamun et al.'s (2006) claim that the amount of smoking during pregnancy plays a crucial role. This discrepancy, however, could be the result of measurement differences in that we include only a dummy variable. The results for the effect of breastfeeding on diet, on the other hand, do echo other findings (cf. Robertson, Lobstein, and Knai, 2007).

For the social-psychological factors of emotional well-being, self-esteem, and an insecure or social personality, a low value on the well-being construct means that the child is emotionally better off. According to our findings, children that are in a positive emotional state, have a high self-esteem, and relate well to others have healthier diets. Thus, in line with the existing evidence (Ferrante et al., 2010, She and Pritchard, 2007, Tiggemann, 2005), in our study, social-psychological factors are associated with diet. Like Ferrante and colleagues (2010), we also find significant differences based on sex. Self-esteem has a greater impact on diet for girls, whereas a social personality is more important for boys. We also observe a strong difference in emotional well-being, which is not at all relevant for boys' diets but definitely matters for girls'. Taking self-esteem and emotional well-being together, girls are generally better off (Table 4), and these factors influence girls' diets more strongly than boys'.

All lifestyle factors measured are also significant. Whereas children who are more active in their leisure time have a healthier diet, a higher AVM consumption is correlated with – and sedentary behaviour strongly associated with – unhealthier diets. Hence, although the literature reports mixed results for the effect of leisure time activities on diet (cf. the reviews of Hastings, 2003, and Livingstone, 2006), our cross-sectional study provides strong support for a relation between screen time and unhealthier diets. Nevertheless our methodology admittedly does not allow differentiation between the primary mechanisms that affect diet: snacking behaviour (Matheson, 2004), interrupted food cues (Swither and Hall, 1994), and the effects of advertising on diet (Phelps, 2004).

We also note an existing familiarity effect; that is, in line with extant research (Baranowski et al., 1993, Cooke et al., 2003, Gillman et al., 2000, Wardle, Carnell, and Cooke, 2005), children with high exposure to healthy food at home have healthier diets, whereas those with high exposure to convenience foods have an unhealthier diet. It remains unclear, however, whether the familiarity effect occurs because of taste preferences, food availability at home, or a mix of both. No sex-based differences emerged.

In terms of the control variables, it is interesting to note that, in line with previous research (Robertson, Lobstein, and Knai, 2007), higher socio-economic status is associated with healthier diets. Likewise, as already indicated by the descriptive statistics, country has an enormous effect.

Variable (bootstrapped: *n* = 500)	**(1)** **All**	**(2)** **Girls**	**(3)** **Boys**
Biological factors			
Breastfed	.037*** (.010)	.036** (.013)	.041** (.014)
Pregnancy: smoking	-.015 (.010)	-.002 (.014)	-.028 (.015)
Social-psychological factors			
Well-being	-.028** (.010)	-.046*** (.014)	-.010 (.014)
Self-esteem	.059*** (.010)	.066*** (.014)	.052*** (.015)
Personality: social	.056*** (.009)	.052*** (.014)	.065*** (.016)
Personality: insecure	-.006 (.010)	-.009 (.012)	-.004 (.013)
Lifestyle factors			
Leisure time	.064*** (.010)	.059*** (.013)	.066*** (.013)
AVM consumption	-.146*** (.011)	-.146*** (.014)	-.147*** (.014)
Familiarity: healthy	.171*** (.009)	.174*** (.013)	.167*** (.013)
Familiarity: convenience	-.090*** (.011)	-.087*** (.014)	-.095*** (.015)
Observations	8,334	4,202	4,132
Adj. R^2	.270	.271	.274

Note: PLS standardized coefficients with bootstrapped standard errors in parentheses. Dependent variable is YHEI for children aged between 2 and 9 years. Control variables are child’s age, parents’ socio-economic status, and country dummies.
Legend: * $p < .05$, ** $p < .01$, *** $p < .001$

Table 5: PLS results for individual diet factors (YHEI)

Overall, our findings indicate that the individual-level biological, social-psychological, and lifestyle factors play an important role in children’s diets, which raises the question of how great the effect is of each. Our results suggest that biological and social-psychological factors tend to have rather small effects on diet, but, based on a comparison of the individual factor coefficients, the lifestyle factors of food familiarity and AVM consumption have the most influential effect on diet.

4.2. Relations between diet and weight status

Because one potential outcome of unhealthy lifestyles is overweight or obesity, we also investigate the relation between diet and children's weight status, whose YHEI levels are summarized in Table 6. We find that the YHEI value for overweight children's does not differ significantly from that for normal weight children: the healthiness of their diets is about the same. Only overweight boys have slightly unhealthier diets than normal weight boys. The diets of obese children, however, are significantly unhealthier than those of normal weight children, especially in the case of boys.

	Weight status		
	Normal	Overweight	Obese
YHEI: all	50.65	50.37	49.26***
(*n*)	(8,636)	(2,279)	(1,387)
YHEI: girls	50.64	50.75	49.96*
(*n*)	(4,149)	(1,062)	(732)
YHEI: boys	50.66	50.05	48.48***
(*n*)	(4,487)	(1,217)	(655)

Note: *t*-tests compare the YHEI values for overweight or obese children with those for normal weight children. Thin children are excluded.
Legend: * $p < .05$, ** $p < .01$, *** $p < .001$

*Table 6: Descriptive statistics for YHEI by weight status and sex (*t*-tests are calculated for group differences between normal weight and other)*

The effects of diet on children – whether normal, overweight, or obese – are given in Table 7 using the standardized coefficients for the diet-weight status relation computed in the second model. In line with the findings reported in the literature (e.g., Craig et al., 2010, Darnton, 2009, Jebb et al., 2004, Jennings et al., 2011), the results for the total sample show a significantly positive relationship between diet and weight status, independent of whether we predict BMI, overweight/obesity, or obesity. Intuitively, an association might be expected between a healthier diet and a lower risk of overweight and obesity. However, this relation has only been found for single food categories. For instance, there is strong evidence for an association between a higher intake of fruits and vegetables and a lower risk of obesity (e.g., Ells et al., 2008) and conversely, for a positive relation between sugar-sweetened beverages and obesity (Moreno and Rodriguez, 2007). Our study, on the other hand, whose healthy eating index is based on nutrition guidelines, unexpectedly reveals a positive relation between diet and weight status. Most probably the result of the cross-sectionality of our data – that is, today's diet influences not today's weight status, but future weight status – this finding also implies a possible reverse causality: weight status influences diet. Particularly striking, and definitely worthy of further investigation, is the gender effect – the sex-stratified model clearly shows that the significant positive association between diet and weight status stems from girls with no observable effect for boys.

Variable (bootstrapped: *n* = 500)	**(1)** **All**	**(2)** **Girls**	**(3)** **Boys**
	Dependent: BMI CDC		
YHEI	.042** (.013)	.068*** (.013)	.013 (.018)
Adj. R^2	.031	.034	.035
	Dependent: overweight/obese		
YHEI	.041** (.012)	.086*** (.016)	-.005 (.017)
Adj. R^2	.049	.060	.044
	Dependent: obese		
YHEI	.030* (.012)	.060*** (.016)	-.004 (.018)
Adj. R^2	.042	.049	.037
Observations	8,334	4,202	4,132

Note: PLS standardized coefficients with bootstrapped standard errors in parentheses. Dependent variable is weight status for children aged between 2 and 9 years measured as BMI (CDC), overweight/obese (dummy), and obese (dummy). Control variables include child's age, parents' socio-economic status, and country dummies.
Legend: * $p < .05$, ** $p < .01$, *** $p < .001$

Table 7: PLS results for diet on children's weight status

5. Discussion

The aim of this study was twofold: (a) to investigate the effects of individual factors on diet and (b) to analyze the association between diet and weight status. To achieve these aims, we adopted a social-ecological approach which assumes that individual biological, social-psychological, and lifestyle factors influence diet, which is in turn associated with weight status. Data were drawn from the IDEFICS study, which provided information for children aged 2 to 9 years on all three factors, as well as on diet and weight status. Methodologically, we employed structural equation modelling;

specifically, a partial least squares approach that allowed inclusion of all factors simultaneously in order to gauge their relative importance for diet.

Our primary findings are the associations between diet and (a) biological factors (breastfeeding), (b) social-psychological factors (emotional well-being, self-esteem, and personality); and (c) lifestyle factors (leisure time activities, sedentary behaviour, and food exposure). We find particularly that sedentary behaviour and food exposure at home have the strongest effects on children's diet, meaning that children who are more exposed to convenience food have an unhealthier diet, whereas children exposed to healthier food have a healthier diet. This observation holds true independent of socio-economic status, country, and age, implying that the handling and choice of food at home – its availability and access – may "nudge" children into either healthier or unhealthier diets (Thaler and Sunstein, 2008). These learned patterns can then develop into habits that are carried through adolescence into adulthood.

This finding on food exposure seems to provide positive support for intervention strategies like smart choice architectures for food environments that promote healthy eating (Reisch and Gwozdz, 2011). Likewise, the opposite effects of leisure time activity and sedentary behaviour imply the wisdom of enhancing non-obesogenic environments by offering playgrounds, biking lanes, safe recreation areas, and sports facilities to promote increased leisure time activity. Nevertheless, the evidence for a substitution effect when sedentary behaviour is exchanged for active leisure time is scarce to none (Epstein et al., 2005, Kaiser Family Foundation, 2005, Taveras et al., 2009).

One outcome of a healthy lifestyle is healthy weight status. Hence, at first glance, the positive association between healthy eating and a higher weight status in girls is surprising. However, given the cross-sectionality of the data, we assume that, rather than the higher weight status resulting from adherence to diet recommendations, there may be a reverse causality at work. That is, today's weight status influences dietary choices. Nevertheless, the sex-based difference is extremely interesting and warrants further analyses to assess the extent to which parental weight perceptions of their children play a role and whether these also differ by sex (Grimmet et al., 2008, Neumark-Sztainer et al., 2007).

Our findings also suggest several other important avenues for further research. For example, future studies might specifically address the longitudinal effects; that is, the effects of today's diet on future weight outcomes. Some such investigation will be possible within the IDEFICS study based on a follow-up survey carried out two years after the baseline survey. In terms of the association between children's diet and weight status, further studies might extend our findings by identifying additional individual factors that influence dietary behaviour and providing suggestions for corresponding intervention strategies. Further research is also needed to explain the complex relationship between diet, physical activity, and weight status, which might be facilitated by the inclusion of additional social, environmental, and societal factors/dimensions. The more that is known about these interrelations, the better the chances for developing successful and sustainable prevention and intervention strategies for health behaviour in general and for obesity in particular.

References

Ahrens, W., Bammann, K., Buchecker, K., De Henauw, S, Iacoviello, L., Hebestreit, A., Krogh, V.,Marild, S., Molnar, D., Moreno, L., Pitsiladis, Y., Reisch, L., Siani, A., Tornaritis, M., Veidebaum, T, & Pigeot, I.(2011). The IDEFICS Study: Design, participation, socio-demographic characteristics and compliance. *International Journal of Obesity, 35,* S3–S15.

Bagozzi, R.P. & Baumgartner, H. (1994).The evaluation of structural equation models and hypothesis testing. In: R.P. Bagozzi (Eds.). *Principles in Marketing Research* (pp. 386–422). Cambridge: Blackwell Publishing.

Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice-Hall.

Baranowski, T., Domel, S., Gould, R., Baranowski, J., Leonard, S., Treiber F., & Mulli, R. (1993). Increasing fruit and vegetable consumption among 4th and 5th grade students: Results from focus groups using reciprocal determinism. *Journal of Nutrition Education, 25*, 114–120.

Beauchamp, G.K. & Mennella, J.A. (2009). Early flavor learning and its impact on later feeding behavior. *Journal of Pediatric Gastroenterology and Nutrition, 48,* S25–S30.

Belk, R.W. (1975). Situational variables and consumer behavior. *Journal of Consumer Research 2*(3), 157–164.

Bollen, K.A. (2000). Modeling strategies: In search of the Holy Grail. *Structural Equation Modeling, 7*(1), 74–81.

Bronfenbrenner, U. (1989). Ecological systems theory. *Annals of Child Development*, 6, 187–249.

Buttriss, J., Stanner, S.,McKevith, B., Nugent,A., Kelly, C., Phillips, F., & Theobald, H.(2004). *A critical review of the psychosocial basis of food choice and identification of tools to effect positive choice – Final report.* London, UK: British Nutrition Foundation for the Food Standards Agency.

Cooke, L.J., Wardle, J., Gibson, E.L., Saponchnik, M., Sheiham, A., & Lawson, M. (2003). Demographic, familial and trait predictors of fruit and vegetable consumption by pre-school children. *Public Health Nutrition, 7*(2), 295–302.

Craig, L.C.A., McNeill, G., Macdiarmid,J.I., Masson,L.F.,&Holmes,B.A. (2010). Dietary patterns of school-age children in Scotland: Association with socio-economic indicators, physical activity and obesity. *British Journal of Nutrition 103*(03), 319-334.

Darnton, A. (2009). *The determinants of obesity – from 'engaging young people and adults in obesity prevention'.* A desktop research report for DH/COI.

Desrochers, D.M. & Holt, D.J. (2007). Children's exposure to television advertising: Implications for childhood obesity. *Journal of Public Policy & Marketing 26*(2), 182–201.

Ells, L.J., Hillier, F.C., Shucksmith,J., Crawley,H., Harbige,L., Shield,J., Wiggins,A., & Summerbell,C.D. (2008). A systematic review of the effect of dietary exposure that could be achieved through normal dietary intake on learning and performance of school-aged children of relevance to UK schools. *British Journal of Nutrition 100*(05), 927–936.

Diliberti, N., Bordi, P.L., Conklin, M.T., Roe, L.S., & Rolls, B.J. (2004). Increased portion size leads to increased energy intake in a restaurant meal. *Obesity, 12*(3), 562–568.

Efron, B., & Gong, G. (1983). A leisurely look at the bootstrap, the jackknife, and cross-validation. *American Statistician, 37*(1), 36–48.

Epstein, L., Roemmich, J., Paluch, R., & Raynor, H. (2005).Physical activity as a substitute for sedentary behavior in youth. *Annals of Behavioral Medicine, 29*(3), 200–209.

Ferrante, M., Fiore, M., Sciacca, G., Leon, L., Sciacca, S., Castaing, M.,& Modonutti, G., (2010). The role of weight status, gender and self-esteem in following a diet among middle-school children in Sicily (Italy). *BMC Public Health, 10*(1), 241-250.

Feskanich, D., Rockett, H., Colditz, R.H., & Graham, A. (2004). Modifying the healthy eating index to assess diet quality in children and adolescents. *Journal of the American Dietetic Association, 104*(9), 1375–1383.

Foresight (2007). *Foresight tackling obesities: Future choices project.* London, UK: Government Office for Science, Department for Innovation, Universities and Skills.

Fornell, C., & Cha, J. (1994). Partial least squares. In R.P. Bagozzi (Eds.). *Advanced methods of marketing research* (pp. 52–78). Cambridge: Blackwell.

French, S.A., Story, M., & Perry, C.L. (1995). Self-esteem and obesity in children and adolescents: A literature review. *Obesity research, 3*(5), 479–490.

Jago, R., Baranowski, T., Baranowski, J.C., Thompson D., & Greaves, K.A. (2005). BMI from 3–6 y of age is predicted by TV viewing and physical activity, not diet. *International Journal of Obesity, 29*, 557–564.

Janssen I., Katzmarzyk, P.T., Boyce, W.F. Vereecken, C., Mulvihill, C., Roberts, C., Currie, C., & Pickett, W. (2005). Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns. *Obesity Reviews, 6*, 123–132.

Jeffery, R.W. & Utter, J. (2003). The changing environment and population obesity in the United States. *Obesity, 11*(10S), 12S–22S.

Jennings, A., Welch, A., van Sluijs, M.F., Griffin, S.J., & Cassidy, A.(2011). Diet quality is independently associated with weight status in children aged 9–10 years. *Journal of Nutrition* (online first).

Gillman, M.W., Rifas-Shiman, S.L., Frazier, A.L., Rockett, H.R.H., Camargo, C.A, Field, Jr., A.E., Berkey, C.S., & Colditz, G.A. (2000). Family dinner and diet quality among older children and adolescents. *Archives of Family Medicine, 9*(3), 235–240.

Grimmett, C., Croker, H., Carnell, S., & Wardle, J. (2008). Telling parents their child's weight status: Psychological impact of a weight-screening program. *Pediatrics, 122*(3), e682–e688.

Hastings, G., Stead, M., McDermott, L., Forsyth, A., MacKintosh, A.M., Rayner, M., Godfrey, C., Caraher, M. & Angus, K. (2003). *Review of research on the effects of food promotion to children.* Centre for Social Marketing.

Homburg, C. & Giering, A. (1996). Konzeptualisierung und Operationalisierung komplexer Konstrukte. *Marketing ZFP, 18*(1), 5–24.

Kaiser Family Foundation (2004). *The role of media on childhood obesity*. February 2004, Washington, DC: Henry Kaiser Family Foundation.

Kane, J.K., Parker, S.L., Matta, S.G., Fu, Y., Sharp, B.M., & Li, M.D. (2000). Nicotine up-regulates expression of orexin and its receptors in rat brain. *Endocrinology, 141*(10), 3623–3629.

Kuczmarski, R.J., Ogden, C.L., & Guo, S.S. (2002). CDC growth charts for the United States: Methods and development: National Center for Health Statistics. *Vital Health Stat, 11*(246), 15–26.

Kumanyika, S., Jeffery, R., Morabia, A., Ritenbaugh, C., & Antipatis, V. (2002). Obesity prevention: The case for action. *International Journal of Obesity*, 26, 425–436.

Lanfer, A., Hebestreit, A., Ahrens, W., Krogh, V., Sieri, S., Lissner, L., Eiben, G., Siani, A., Huybrechts, I., Loit, H-L., Papoutsou, S., Kovács, E. & Pala, V. (2011). Reproducibility of food consumption frequencies derived from the Children's Eating Habits Questionnaire used in the IDEFICS study. *International Journal of Obesity, 35*, S61–S68.

Latner, J.D. & Stunkard, A.J. (2003). Getting worse: The stigmatization of obese children. *Obesity Research, 11*, 452–456.

Leathwood, P. & Maier, A. (2005). Feeding during late infancy and early childhood: Impact on health: early influences on taste preferences. In: O.Hernell& J. Schmitz (Eds.). *Feeding during late infancy and early childhood: Impact on health* (pp 127–141). Nestlé Nutrition Institute Workshop Series: Pediatric Program, 56, Basel: Karger.

Livingstone, S. & Helsper, E.J. (2006). Does advertising literacy mediate the effects of advertising on children? A critical examination of two linked research literatures in relation to obesity and food choice. *Journal of Communication, 56*(3), 560–584.

Matheson, D.M., J. D. Killen, Wang, Y., Varady, A. & Robinson, T.N. (2004). Children's food consumption during television viewing. *American Journal of Clinical Nutrition, 79*(6), 1088–1094.

Mamun, A.A., Lawlor, D.A., Alati, R., O'Callaghan, M., Najman, J.M., Williams, G.M., & Bor, W. (2006). Does maternal smoking during pregnancy have a direct effect on future offspring obesity? Evidence from a prospective birth cohort study. *American Journal of Epidemiology, 164*(4), 317–325.

Mendez, M.A., Torrent, M., Ferrer, C., Ribas-Fitó, N., & Sunyer, J. (2008). Maternal smoking very early in pregnancy is related to child overweight at age 5–7 y. *American Journal of Clinical Nutrition, 87*(6): 1906-1913.

Moreno, L.A. & Rodríguez, G. (2007). Dietary risk factors for development of childhood obesity. *Current Opinion in Clinical Nutrition & Metabolic Care*, *10*(3), 336–341.

National Health Service (2008). *Healthy weight, healthy lives: A toolkit for developing local strategies*. Dr Kerry Swanton at the National Heart Forum for the NHS, October 2008.

Neumark-Sztainer, D., Wall, M., Haines, J.I., Story, M.T., Sherwood, N.E. & Berg, P.A. (2007). Shared risk and protective factors for overweight and disordered eating in adolescents. *American Journal of Preventive Medicine, 33*(5), 359–369.

Owen, C.G., Martin, R.M., Whincup, P.H., Smith, G.D., & Cook, D.G. (2005). Effect of infant feeding on the risk of obesity across the life course: A quantitative review of published evidence. *Pediatrics, 115*(5), 1367–1377.

Phelps, E. (2006). Emotion and cognition: Insights from studies of the human amygdala. *Annual Review of Psychology, 57*, 27–53.

Popkin, B. (2005). Using research on the obesity pandemic as a guide to a unified vision of nutrition. *Public Health Nutrition*, 8(6A), 724–729.

Power, C. & Jefferis, B.J. (2002). Fetal environment and subsequent obesity: A study of maternal smoking. *International Journal of Epidemiology, 31*(2), 413–419.

Procter, K.L. (2007). The aetiology of childhood obesity: A review. *Nutrition Research Reviews, 20*(1), 29–45.

Reilly, J.J. (2007). Childhood obesity: An overview. *Children & Society*, 21(5), 390–396.

Reilly, J.J., Armstrong, J., Dorosty, A.R., Emmett, Pauline, M., & Ness, A. (2005). Early life risk factors for obesity in childhood: Cohort study. *BMJ, 330*, 1357.

Reisch, L. & Gwozdz, W. (2011). Chubby cheeks and climate change: Childhood obesity as a sustainable development issue. *International Journal of Consumer Studies, 35*(1), 3–9.

Reisch, L., Gwozdz, W., & Beckmann, S. (2011). Consumer behavior in childhood obesity research and policy. In: L.A. Moreno, I. Pigeot, & W. Ahrens (Eds.). *Epidemiology of Obesity in Children and Adolescents,* (pp. 431–454). New York, NY: Springer.

Roedder John, D. (2008). Stages of consumer socialization: The development of consumer knowledge, skills, and values from childhood to adolescence. In: C. Haugvedt, P. Herr, and F. Kardes (Eds.). *The handbook of consumer psychology* (pp. 221–246). New York, NY: Lawrence Earlbaum Associates.

Robertson, A., Lobstein, T., & Knai, C. (2007). *Obesity and socio-economic groups in Europe: Evidence review and implications for action*. European Commission – DGSANCO.

Scharff, R.L. (2009). Obesity and hyperbolic discounting: Evidence and implications. *Journal of Consumer Policy*, 32(1), 3–21.

Sellers, K., Russo, T.J., Baker, I., and Dennison, B.A. (2005). The role of childcare providers in the prevention of childhood overweight. *Journal of Early Childhood Research, 3*(3), 227–242.

Sharma, A.J., Cogswell, M.E., Whincup, P.H., Smith, G.D., & Cook, D.G. (2008). Dose-response associations between maternal smoking during pregnancy and subsequent childhood obesity: Effect modification by maternal race/ethnicity in a low-income US cohort. *American Journal of Epidemiology, 168*(9), 995–1007.

Shea, M. &Pritchard, M. (2007). Is self-esteem the primary predictor of disordered eating? *Personality and Individual Differences, 42*, 1527–1537.

Slotkin, T.A. (1998). Fetal nicotine or cocaine exposure: Which one is worse? *Journal of Pharmacology and Experimental Therapeutics, 285*(3), 931–945.

Story, M., Kaphingst, K.M., Robinson-O'Brien, R., & Glanz, K. (2008). Creating healthy food and eating environments: Policy and environmental approaches. *Annual Review of Public Health, 29*(1), 253–272.

Story, M., Neumark-Sztainer, D., & French, S. (2002). Individual and environmental influences on adolescent eating behaviours. *Journal of the American Dietetic Association, 102*(3, S1), S40–S51.

Strauss, R.S. (2000). Childhood obesity and self-esteem. *Pediatrics, 105*(1), e15.

Swithers, S.E. & Hall, W.G. (1994). Does oral experience terminate ingestion? *Appetite, 23*(2), 113–138.

Taveras, E.M., Field, A.E., Berkey, C.S., Rifas-Shiman, S.L., Frazier, A.L., Colditz, G.A., & Gillman, M.W. (2007). Longitudinal relationship between television viewing and leisure-time physical activity during adolescence. *Pediatrics, 119*(2), e314–e319.

Tenenhaus, M., Vinci, V.E., Chatelin, Y.M., & Lauro, C. (2005). PLS path modeling. *Computational Statistics & Data Analysis*, *48*, 159–205.

Temple, J.L., Giacomelli, A.M., Kent, K.M., Roemmich, J.N., & Epstein, L.H. (2007). Television watching increases motivated responding for food and energy intake in children. *American Journal of Clinical Nutrition*, *85*(2), 355–361.

Thaler, R.H. & Sunstein, C.R. (2008). *Nudge – Improving decisions about health, wealth, and happiness*. New Haven, CT: Yale University Press.

Tiggemann, M. (2005). Body dissatisfaction and adolescent self-esteem: Prospective findings. *Body Image, 2*, 129–135.

Toschke, A.M., Montgomery, S.M., Pfeiffer, U., & von Kries, R. (2003). Early intrauterine exposure to tobacco-inhaled products and obesity. *American Journal of Epidemiology, 158*(11), 1068–1074.

Trost, S.G., Sirard, J.R., Dowda, M., Pfeiffer, K.A., & Pate, R.R. (2003). Physical activity in overweight and nonoverweight preschool children. *International Journal of Obesity, 37*, 834–839.

Veugelers, P.J. & Fitzgerald, A.L. (2005). Prevalence of and risk factors for childhood overweight and obesity. *Canadian Medical Association Journal, 173*(6), 607–613.

von Kries, R., Toschke, A.M., Koletzko, B., & Slikker, W.(2002). Maternal smoking during pregnancy and childhood obesity. *American Journal of Epidemiology, 156*(10), 954–961.

Wardle, J. (2007). Eating behaviour and obesity – Foresight short science review. *Obesity Reviews, 8*(s1), 73–75.

Wardle J., Carnell, S., & Cooke, L. (2005). Parental control over feeding and children's fruit and vegetable intake: How are they related? *Journal of the American Dietary Association, 105*(2), 227–232.

Wold, H. (1982). Systems under indirect observation using PLS. In: C. Fornell (Eds.). *A second generation of multivariate analysis* (pp. 325–347). New York: John Wiley & Sons.

Wold, H. (1985). Partial least squares. In: S. Kotz & N.L. Johnson (Eds.). *Encyclopedia of statistical sciences*, vol. 6, (pp. 581–591). New York: Wiley.

Appendix

Table A1: Descriptive statistics for manifest variables used

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Dependent variables					
YHEI	13,622	50.45	8.497	17.8	84.9
Weight status: BMI CDC	16,208	55.86	30.876	0	100
Weight status: overweight/obese	16,223	.24	.428	0	1
Weight status: obese	16,223	.07	.254	0	1
Biological factors					
Breastfed	13,968	.55	.497	0	1.00
Pregnancy: smoking	16,223	.13	.340	0	1
Social-psychological factors					
Well-being a)	14,782	.71	.793	0	3.00
Well-being b)	14,770	.49	.732	0	3
Well-being c)	14,790	.61	.792	0	3
Self-esteem a)	14,791	2.55	.558	0	3
Self-esteem b)	14,700	2.37	.730	0	3
Self-esteem c)	14,756	2.58	.567	0	3
Personality: social a)	14,640	1.53	.549	0	2
Personality: social b)	14,832	1.44	.577	0	3
Personality: social c)	14,783	1.51	.557	0	2
Personality: insecure a)	14,759	.56	.658	0	2
Personality: insecure b)	14,807	.41	.610	0	2
Lifestyle factors					
Leisure time: physical activity	15,177	17.81	11.274	0.0	158.0
Leisure time: leisure time activity	14,844	25.51	16.763	0.0	91.0
AVM consumption: weekday	15,250	1.40	1.003	0	8
AVM consumption: weekend	15,170	2.36	1.418	0	8
Familiarity: healthy foods a)	14,137	3.13	1.367	1	5
Familiarity: healthy foods b)	14,254	3.77	1.233	1	5
Familiarity: healthy foods c)	14,298	3.51	1.288	1	5
Familiarity: convenience foods a)	14,318	1.74	.940	1	5
Familiarity: convenience foods b)	14,336	1.55	.863	1	5
Controls					
Age: 2 years	16,223	.04	.188	0	1
Age: 3 years	16,223	.14	.342	0	1
Age: 4 years	16,223	.16	.364	0	1
Age: 5 years	16,223	.13	.331	0	1
Age: 6 years	16,223	.17	.372	0	1
Age: 8 years	16,223	.14	.348	0	1
Age: 9 years	16,223	.01	.113	0	1
SES: ISCED mother	14,575	3.69	1.157	1	6
SES: ISCED father	13,788	3.59	1.167	1	6
SES: household net income	13,914	5.24	2.449	1	9
Country: Italy	16,223	.14	.346	0	1
Country: Cyprus	16,223	.15	.354	0	1

Country: Spain	16,223	.09	.290	0	1
Country: Hungary	16,223	.16	.365	0	1
Country: Estonia	16,223	.11	.308	0	1
Country: Sweden	16,223	.11	.315	0	1
Country: Belgium	16,223	.12	.323	0	1
Country: Germany	16,223	.13	.333	0	1