British Journal of Nutrition (2013), 109, 137–147 doi:10.1017/S0007114512000682

British Journal of Nutrition

Socio-demographic and lifestyle determinants of 'Western-like' and 'Health conscious' dietary patterns in toddlers

Jessica C. Kiefte-de Jong[1,2], Jeanne H. de Vries[3], Sacha E. Bleeker[1,2], Vincent W. V. Jaddoe[1,2,4], Albert Hofman[4], Hein Raat[5] and Henriette A. Moll[2]*

[1]*The Generation R Study Group, Erasmus University Medical Center, Rotterdam, The Netherlands*
[2]*Department of Paediatrics, Erasmus University Medical Center, PO Box 2060, 3000 CB Rotterdam, The Netherlands*
[3]*Department of Human Nutrition, Wageningen University, Wageningen, The Netherlands,*
[4]*Department of Epidemiology, Erasmus University Medical Center, Rotterdam, The Netherlands*
[5]*Department of Public Health, Erasmus University Medical Center, Rotterdam, The Netherlands*

(Submitted 28 September 2011 – Final revision received 9 January 2012 – Accepted 28 January 2012 – First published online 5 April 2012)

Abstract

Determinants of a child's diet shortly after weaning and lactation have been relatively understudied. The aim of the present study was hence to identify common dietary patterns in toddlers and to explore parental and child indicators of these dietary patterns. The study was a population-based, prospective birth-cohort study in Rotterdam, the Netherlands. Food consumption data of 2420 children aged 14 months were used. A 'Health conscious' dietary pattern characterised by pasta, fruits, vegetables, oils, legumes and fish, and a 'Western-like' dietary pattern characterised by snacks, animal fats, confectionery and sugar-containing beverages were extracted using principal component analysis. Low paternal education, low household income, parental smoking, multiparity, maternal BMI, maternal carbohydrate intake and television-watching of child were determinants of a 'Western-like' diet, whereas parental age, dietary fibre intake during pregnancy, introduction of solids after 6 months and female sex were inversely associated with a 'Western-like' diet of the child. Maternal comorbidity, alcohol consumption during pregnancy and female sex were inversely associated with a 'Health conscious' dietary pattern of the child, while single parenthood, folic acid use and dietary fibre intake during pregnancy were positively associated. All aforementioned associations were statistically significant. In conclusion, both 'Western-like' and 'Health conscious' diets can already be identified in toddlers. Particularly, adherence to a 'Western-like' diet is associated with unfavourable lifestyle factors of the parents and child, and low socio-economic background. These findings can form a basis for future epidemiological studies regarding dietary patterns and health outcomes in young children.

Key words: Dietary patterns: Paediatric nutrition: Socio-economic determinants: Principal component analysis

Adequate nutrition is fundamental from infancy until adult life. However, the increase in the rates of chronic diseases such as obesity may suggest that children are not using an optimal diet, since studies show that nutritional practice in early childhood has a role in the aetiology of obesity[1].

There is evidence that many obesity-promoting behaviours, including unhealthy eating habits that are learnt during childhood, track to adulthood[2]. The social environment is very important for young children to develop eating habits[3]. Not only has the parent's lifestyle been shown to play a significant role in the development of a healthy diet in children[4], but also parental education and financial background are associated with children's eating behaviour[5]. Similarly, it has been demonstrated that longer television (TV) watching is linked to a higher consumption of salted and sugary snacks in children[6].

Particularly, feeding patterns in the first year of life have been studied to a great extent, but the primary objective of these studies was to assess the socio-demographic determinants of breast- or bottle-feeding[7] along with complementary feeding[8], whereas determinants of a child's diet shortly after the weaning and lactation period have been relatively understudied.

During the last decennium, an alternative approach within nutritional research has been developed by using dietary patterns analysis[9,10]. This approach takes into account that dietary components can be highly correlated with each other, and hence represents a more comprehensive reflection of food consumption than assessing single nutrients or foods[9,10].

Abbreviations: ALSPAC, Avon Longitudinal Study of Pregnancy and Childhood; TV, television.

* **Corresponding author:** Professor Dr H. A. Moll, fax +31 107036685, email h.a.moll@erasmusmc.nl

https://doi.org/10.1017/S0007114512000682 Published online by Cambridge University Press

In addition, several studies have shown in adults that a 'Western' dietary pattern is associated with an increased risk of obesity[11,12] and metabolic disease[13], whereas 'Healthy' dietary patterns are associated with a lower all-cause mortality in adults[13]. So far, dietary patterns in toddlers have not had extensive study yet. However, to identify young children at potential risk for unhealthy eating behaviour and in order to develop targeted strategies to improve adequate nutrition during infancy and childhood, knowledge about common dietary patterns in very young children and their determinants will be important. Dietitians and healthcare workers can provide targeted guidance to promote the development of healthy eating when taking into account the combination of different food items that young children eat. Also, to perform further studies on dietary patterns and various health outcomes in toddlers, knowledge about these determinants to elucidate potential confounders or mediators is necessary. For this reason, the aim of the present study was to assess whether certain dietary patterns may already be observed among toddlers and further identify parental and child determinants of adherence to these dietary patterns.

Material and methods

Study population

This study was embedded in a population-based prospective cohort study from fetal life until young adulthood in Rotterdam, the Netherlands and has been described in detail previously[14].

In total, 9778 mothers with a delivery date between April 2002 and January 2006 were enrolled in the study, of which 7893 provided consent for follow-up. From 2003 onwards, data collection on nutritional intake at the age of 14 months was implemented in the study. In total, 5088 mothers received an FFQ for their child at 14 months of age (Fig. 1). This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Medical Ethical Committee of the Erasmus University Medical Center, Rotterdam, the Netherlands. Written informed consent was obtained from all subjects.

Dietary assessment of the children

Out of 5088 mothers who received the FFQ to assess the child's nutrition, 3643 (72 %) filled in the FFQ and were eligible for analysis (Fig. 1). The FFQ was developed in cooperation with the division of Human Nutrition of Wageningen University, The Netherlands and based on an existing validated FFQ developed and described in detail previously[15]. This existing FFQ was modified by only comprising foods frequently consumed during the second year of life according to a National Dutch food consumption survey in 941 Dutch children aged 9–18 months[16]. In addition, only foods contributing $\geq$0·1 % of the total consumption of energy, protein, fat, carbohydrates and dietary fibre in the latter survey were incorporated in the FFQ. The final FFQ was validated against 3 d 24 h-recalls carried out by trained nutritionists in a representative sample of Dutch children aged 14 months living in Rotterdam, the Netherlands. This validation showed the following intra-class correlation coefficients for macronutrients: total energy, 0·4; total protein, 0·7; total fat, 0·4; carbohydrates, 0·4; dietary fibre, 0·7. The final FFQ consisted of 211 food items and included questions on the frequency of consumption of these food items over the last month, the amount and type of the food item, and preparation methods. Portion sizes in grams per d were estimated using standardised household measures[17]. To calculate average daily nutritional values, the Dutch food composition Table 2006 was used[18].

A total energy intake of $<$1260 or $>$12 600 kJ/d ($<$300 or $>$3000 kcal/d) was considered as implausible values for total energy intake. However, sensitivity analyses showed no different results when excluding these values, and therefore these children were kept in the final dietary pattern analyses.

The interquartile range of the child's age, when the FFQ was filled out, ranged from 12 to 14 months with a minimum age of 11·6 months and a maximum age of 33 months. Since sensitivity analyses showed similar results even when excluding outliers (age above the 99th percentile: 20 months of age), children older than 20 months were kept in the final analyses.

Dietary pattern analysis was restricted to children with a Dutch ethnicity (n 2420), since the definitions of dietary patterns can be race-specific[19] and because this FFQ was only valid in this population. Ethnicity of the child was defined as follows: if both parents were born in the Netherlands, the ethnicity was defined as Dutch; if one of the parents was born in another country than the Netherlands, that country applied; if parents were born in different countries other than the Netherlands, the country of the mother applied[20].

Parental indicators

From obstetric records assessed in mid-wife practices and hospital registries, data on maternal age, BMI and parity at intake were available[14]. Total macronutrient intake during pregnancy was assessed at intake (median 13·5 weeks of gestation, range: 3·4) using a validated semi-quantitative FFQ of Klipstein-Grobusch *et al.*[21]. Only the energy-providing nutrients – total fat and carbohydrate intake during pregnancy – were used as predictors in this study, since they are associated with both diet and fat mass in the offspring[22]. Adjustment for total energy intake was performed by a multivariate nutrient density method[23,24]. Other prenatal questionnaires completed by the mother included information on mother's educational level, household income, maternal smoking, maternal alcohol consumption, folic acid supplementation during pregnancy, marital status, co-morbidity (i.e. any history of or medical treatment for depression, anxiety, diabetes mellitus, hypertension or hypercholesterolaemia). Folic acid exposure during early pregnancy was assessed by a questionnaire that included the following question: 'Have you taken folic acid, either as a single supplement or as part of multivitamin supplement during the first trimester?' Partners of the mothers received one questionnaire in the prenatal phase, which included information on paternal education, age, smoking, and any history or medical treatment for diabetes mellitus, hypertension or hypercholesterolaemia.

https://doi.org/10.1017/S0007114512000682 Published online by Cambridge University Press

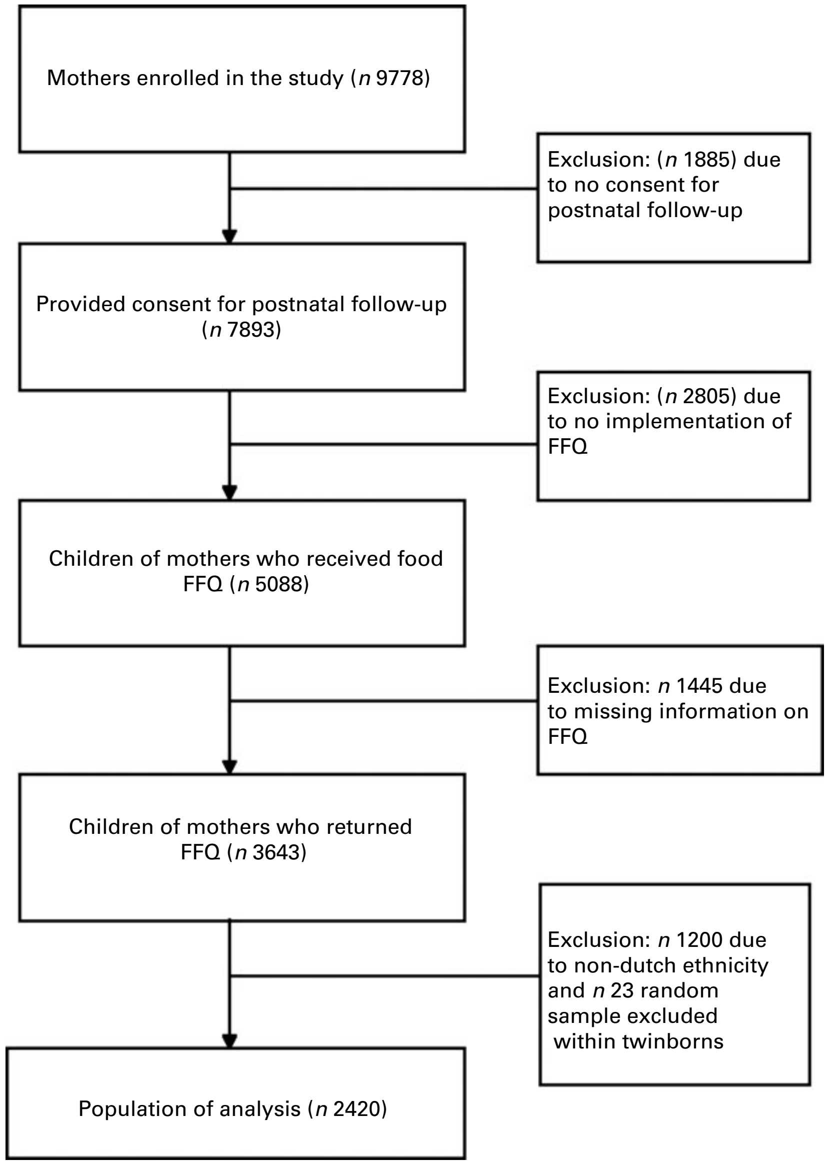

Fig. 1. Flow chart of participants included for analysis.

Level of maternal and paternal education was defined as follows: (I) low: no education, elementary or middle school or less than 4 years of high school, (II) mid: college, associate degree or Bachelor's degree and (III) high: Master's degree[25].

Child indicators

Sex of the child, birth weight and gestational age were available from obstetric records and hospital registries[14]. Timing of introduction of solids in the first year of life was retrospectively assessed by supplementary questions in addition to the FFQ at the age of 14 months. Parents were asked at what age they had first introduced solids in the child's diet in addition to breast- or bottle-feeding, which we coded in two categories: before the age of 6 months or 6 months and later according to the feeding recommendations of the WHO[26]. After the age of 6 months, all children received complementary feeding.

Breast-feeding duration was assessed according to five indicators: ever breast-feeding, cessation of breast-feeding and receiving any breast-feeding at the age of 2, 6 and 12 months. Data on ever breast-feeding were collected from delivery reports and data on breast-feeding cessation or continuation were derived from postnatal questionnaires at 2, 6 and 12 months of age. Accordingly, breast-feeding was categorised into the following three groups: (I) never breast-feeding, (II) any partial breast-feeding in the first 4 months of life and (III) any full breast-feeding in the first 4 months of life. A definition of full breast-feeding was established on the basis of whether the child received breast-feeding without any other formula feeding, milk or solids. Partial breast-feeding indicated children receiving both breast-feeding and formula feeding and/or solids in this period.

The presence of cows' milk allergy was obtained by questionnaires at the age of 6 and 12 months, in which parents were retrospectively asked whether their child had a history of doctor-attended cows' milk allergy. At the age of 12 months, questionnaire data were available on additional care-giving of the child by au-pair or daycare. The duration of TV watching during weekdays and weekend days was assessed by questionnaire in the second year of the child's life. According to the American Academy of Paediatrics, the answer categories were divided into <2 h/d and ≥ 2 h/d[27]. Height and weight were measured at the Community Child Health Centres at the age of 14 months. Height was measured in standing position by a Harpenden stadiometer (Holtain Limited). Weight was measured using a mechanical personal scale (SECA). Weight-for-age and height-for-age z-score was calculated from the national reference using the Growth Analyzer program (http://www.growthanalyser.org)[28].

Statistical methods

All 211 food items from the FFQ data of all Dutch children (n 2420) were classified into twenty-one food groups on the basis of the Dutch food consumption survey among pre-school children[16] and nutrient content (Table S1 of the supplementary material, available at http://www.journals.cambridge.org/bjn). Subsequently, we applied principal component analysis on twenty-one food groups (assessed in g/d) of the children to construct overall dietary patterns by explaining the largest proportion of variation in the food group intake[10]. To reduce correlation between the factors, the varimax method by maximising the sum of the variance of the loading components was used[29]. To reduce bias as a result of multiple testing and to better identify common dietary patterns, only the dietary patterns with an eigenvalue of $\geq 1{\cdot}5$ were extracted. This cut-off was on the basis of the scree plots, which indicated a clear break after the second factor (i.e. dietary pattern) with an eigenvalue of 1·7[30] (Table 1). These two dietary patterns accounted for 24·5 % of the variability in food consumption within our study population. Accordingly, regression-based factor scores were extracted and used as adherence scores of these dietary patterns.

To assess the association between adherence to the dietary pattern and each of the potential parental and child indicators, we included all indicators simultaneously in a multivariate linear regression model. The addition of these potential indicators was predominantly on the basis of previous studies in toddlers and pre-school children[5,22,31–34]. Additionally, folic acid supplementation during pregnancy was added as a proxy for other health behaviours of the mother during pregnancy[35]. In order to improve the model fit, these analyses were followed-up by a backward stepwise elimination procedure retaining only the strongest predictors, with $P=0{\cdot}10$ as endpoint.

To diminish potential bias associated with attrition, the missing values of subject characteristics (approximately 0·1–28 %) were multiple imputed (n 5 imputed data sets). The multiple imputation was based on the correlation between each variable with missing values with the other subject characteristics as described previously in detail[36,37]. Briefly, the multiple imputation procedure begins with generating five copies of the original data set, each with missing values replaced by values randomly generated from the predictive distribution on the basis of the correlation between each variable with missing values and the other subject characteristics. The second stage is that the main statistical analyses (i.e. regression analyses) are repeated in each of the five imputed data sets. The final effect sizes (β or regression coefficients) are estimated by taking the average effect size of the five imputed data sets. To calculate the 95 % CI, the combined standard errors from the five imputed data sets were calculated using Rubin's rules[37], taking into account the uncertainty associated with the missing data. Analyses were repeated in the original data and after the multiple imputation procedure. Since we found similar results, the final results in the present paper are presented as the pooled β with its 95 % CI after the multiple imputation procedure. A P value $<0{\cdot}05$ was considered as statistically significant.

Results

The observed correlations of the food groups for the two constructed dietary patterns are presented in Table 1. Component 1 represented a 'Health conscious' dietary pattern characterised by high intake of fruit, vegetables, legumes and fish. Component 2 represented a 'Western-like' dietary pattern comprising high intakes of savoury and snacks, animal fats, confectionery and sugar-containing beverages (Table 1). Adherence score ranged from $-1{\cdot}91$ to 7·47 for the 'Health conscious' dietary pattern and from $-2{\cdot}09$ to 8·43 for the 'Western-like' dietary pattern. Characteristics of the study population are shown in Table 2.

Determinants of adherence to a 'Western-like' dietary pattern of the child

Multivariate associations between parental and child indicators and adherence to a 'Western-like' dietary pattern are presented in Table 3.

In the multivariate model that included all parental and child indicators kept after the backward selection procedure, low paternal educational background ($P<0{\cdot}01$), low household income ($P<0{\cdot}01$), parental smoking ($P<0{\cdot}01$), high maternal BMI ($P<0{\cdot}01$), high intake of carbohydrates ($P=0{\cdot}01$, after adjustment for total energy intake) and multiparity ($P<0{\cdot}01$) were significantly associated with a higher adherence to a 'Western-like' dietary pattern of the child. High dietary fibre intake during pregnancy ($P<0{\cdot}01$, after adjustment for total energy intake) and high parental age ($P\leq 0{\cdot}01$) were inversely associated with adherence to a 'Western-like' dietary pattern of the child.

Adherence to a 'Western-like' dietary pattern of the child was significantly associated with a higher age of food assessment ($P<0{\cdot}01$) and more TV watching in the second year of the child's life ($P<0{\cdot}01$). Children who where female ($P<0{\cdot}01$) and children who received solids after the recommended age of 6 months ($P<0{\cdot}01$) had a lower adherence score on a 'Western-like' dietary pattern (Table 3).

Table 1. Characteristics of the 'Health conscious' and 'Western-like' dietary patterns in Dutch children aged 14 months (retaining factor loadings >0·2 or <−0·2)

		Factor loading	
	Mean intake (g/d)	'Health conscious' dietary pattern	'Western-like' dietary pattern
Food group			
Refined bread and breakfast cereals	15	–	0·57
Whole bread and breakfast cereals	62	–	–
Pasta and rice	23	0·62	–
Dairy	626	–	–
Fruit	162	0·32	–
Soya substitutes	4	–	–
Vegetables	52	0·74	–
Potatoes	34	0·61	–
Soups and sauces	9	–	0·23
Savoury snacks	4	–	0·59
Confectionery	28	–	0·72
Vegetable oils	1	0·50	–
Other fats	11	–	0·58
Fish	8	0·22	–
Shellfish	0·3	–	–
Meat	26	0·21	0·27
Eggs	2	–	–
Legumes	4	0·59	–
Sugar-containing beverages	198	–	0·59
Non-sugar-containing beverages	56	–	–
Composite dishes	102	–	–
Eigen value†		3·4	1·7
Variance explained (%)		16·3	8·2
		Pearson's correlation coefficient‡	
Nutrients			
Energy (kJ)	5339	0·3*	0·5*
Proteins (en%)	13	0·10*	−0·20*
Fat (en%)	28	−0·10*	0·10*
Saturated fat (en%)	10	−0·10*	0·11*
Monounsaturated fat (en%)	8	−0·02	0·10*
Polyunsaturated fat (en%)	5	0·10*	0·20*
Carbohydrates (en%)	59	0·02	0·03
Mono- and disaccharides (en%)	35	−0·02	0·13*
Polysaccharides (en%)	24	0·23*	−0·13*
Dietary fibre (g)	18	–	–

En%, energy percentage.
* $P<0·05$.
† The eigen value was used as indicator of the amount of variation explained by each dietary pattern.
‡ Principal component analysis was used as an extraction method in which the factor score represents the relative contribution of that food group to the identified dietary pattern.

Determinants of adherence to a 'Health conscious' dietary pattern of the child

Predictors of adherence to a 'Health conscious' dietary pattern of the child are presented in Table 4.

In multiple regression analyses, children of mothers who consumed alcohol during pregnancy ($P=0·04$) and whose mothers had a history of co-morbidity ($P<0·05$), and children who were female ($P=0·03$) had a lower adherence score on a 'Health conscious' dietary pattern. Folic acid supplementation during pregnancy ($P=0·02$), high dietary fibre intake of the mother ($P<0·01$, after adjustment for total energy intake) and single parenthood ($P<0·01$) were positively associated with adherence to a 'Health conscious' dietary pattern of the child (Table 4). Children who received any full breast-feeding in the first 4 months of life had a higher score on a 'Health conscious' dietary pattern ($P<0·05$, Table 4).

Discussion

The results from this prospective cohort study among children aged 14 months have several points with potential health implications that need to be emphasised.

First, a 'Western-like' dietary pattern was already identifiable in the second year of the child's life. We found a 'Western-like' dietary pattern that was characterised by high consumption of refined grains, savoury snacks, confectionery, animal fats and sugar-containing beverages. An increase in the consumption of sugar-containing beverages is considered to be related to poor diet quality[38]. Also, consumption of sugar-containing beverages has been shown to be correlated to other unhealthy food choices such as savoury snacks and sweets[39]. From the Bogalusa Heart Study, it is known that mean intake of sugar-containing beverages, snacks and sweets increases from childhood until adulthood, with an overall decrease in diet

https://doi.org/10.1017/S0007114512000682 Published online by Cambridge University Press

Table 2. Parental and child characteristics of the study population

(Number of participants and percentages; mean values and standard deviations, *n* 2420)

	n	%
Mother		
Maternal educational background		
Low	41	2
Mid	1703	70
High	677	28
Household income per month		
< 2000 euro	301	12
≥ 2000 euro	2119	88
Marital status		
Married/living together	2298	95
No partner	122	5
Smoking during pregnancy	508	21
Alcohol consumption during pregnancy	1420	59
Maternal BMI (kg/m^2)		
Mean	24	
SD	4	
Folic acid supplementation in early pregnancy	2230	92
Total energy intake during pregnancy (kJ/d)		
Mean	9000	
SD	2045	
Total protein during pregnancy (en%/d)		
Mean	15	
SD	2	
Total fat intake during pregnancy (en%/d)		
Mean	37	
SD	5	
Saturated fat intake during pregnancy (en%/d)		
Mean	13	
SD	2	
Monounsaturated fat intake during pregnancy (en%/d)		
Mean	13	
SD	2	
Polyunsaturated fat intake during pregnancy (en%/d)		
Mean	7	
SD	2	
Total carbohydrate intake during pregnancy (en%/d)		
Mean	48	
SD	6	
Total dietary fibre intake during pregnancy (g/MJ)		
Mean	3	
SD	1	
Maternal age (years)		
Mean	32	
SD	4·2	
Nulliparous	1498	62
Maternal history of diabetes mellitus	128	5
Maternal history of hypertension	172	7
Maternal history of hypercholesterolaemia	388	16
Father		
Paternal educational background		
Low	87	4
Mid	828	34
High	1505	62
Paternal smoking	962	40
Paternal BMI (kg/m^2)		
Mean	25	
SD	3	
Paternal age (years)		
Mean	34	
SD	5	
Paternal history of diabetes mellitus	183	8
Paternal history of hypertension	93	4
Paternal history of hypercholesterolaemia	166	7
Child		
Age of food assessment (months)		
Mean	14	
SD	2	
Male sex	1201	50
Birth weight (g)		
Mean	3503	
SD	570	
Gestational age (weeks)		
Mean	39·9	
SD	1·7	
Never breast-feeding	302	13
Partial breast-feeding until 4 months of age	1439	59
Full breast-feeding until 4 months of age	679	28
Timing of introduction of solids ≤6 months of age	1628	67
History of food allergy in the first year of life	152	6
Daycare or au-pair in the first year of life > 16 h/week	1640	68
Weight for age *z*-score		
Mean	−0·1	
SD	0·9	
Height for age *z*-score		
Mean	−0·2	
SD	0·9	
TV watching ≥ 2 h/d	335	14

En%, energy percentage; TV, television.

quality over the years[40]. Indeed, we found that the older the child was at the moment of food assessment, the more likely it was to adhere to a 'Western-like' dietary pattern. If we assume that adherence to a 'Western-like' diet may track from pre-school age to child- and adulthood onwards, then interventions to promote a healthy diet should start early in the child's life[41].

Second, we demonstrated that paternal education, household income, maternal and paternal smoking, maternal BMI, parental age, parity, early solids introduction and TV watching are important predictors of adherence to a 'Western-like' dietary pattern of the child. Maternal BMI has been previously reported to be associated with sweets and sugar intake in 1-year-olds[32]. Similarly, maternal smoking during pregnancy and TV viewing more than 2 h a day showed a significant positive association with unhealthy eating behaviour in other studies among children[5,31,42]. In infancy, early solid-food introduction has been found to be related to poor dietary quality in the first year of life[43]. The Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC) study showed that the number of older siblings is positively associated with adherence to a 'Junk' and 'Snack' dietary pattern[5], which is in line with our results since we found a positive correlation between parity and adherence to a 'Western-like' dietary pattern of the child. Also, the ALSPAC study found that boys were less likely to adhere to a 'Healthy' and 'Traditional' dietary pattern[5]. In our study, we found that girls had lower scores on the 'Western-like' diet along with a 'Health conscious' dietary pattern, suggesting differences in food preferences between boys and girls. Low paternal education and low household income were associated with the 'Western-like' dietary pattern, which is in accordance with other studies indicating social inequalities in unhealthy eating patterns[3].

We found that high carbohydrate and low dietary fibre intake of the mother during pregnancy was significantly associated with adherence to a 'Western-like' dietary pattern of the child. An earlier study already showed a strong correlation between

Table 3. Predictors of adherence to a 'Western-like' dietary pattern of children aged 14 months
(Regression coefficients (*β*) and 95 % confidence intervals, *n* 2420)

	Multivariate regression (fully adjusted model)			Multivariate regression model after stepwise backward selection*		
	β†	95 % CI	*P*	*β*	95 % CI	*P*
Maternal indicators						
Maternal educational background at intake						
Mid *v.* high (reference)	0·05	−0·06, 0·15	0·38		–	
Low *v.* high (reference)	0·17	−0·29, 0·64	0·47		–	
Household income at intake						
< 2000 euro *v.* ≥2000 euro (reference)	0·21	0·05, 0·38	0·01	0·19	0·07, 0·32	<0·01
Marital status at intake						
Living alone *v.* married/living together (reference)	−0·17	−0·42, 0·09	0·21		–	
Maternal smoking during pregnancy						
Yes *v.* no (reference)	0·16	0·02, 0·29	0·02	0·16	0·04, 0·27	<0·01
Maternal alcohol consumption during pregnancy						
Yes *v.* no (reference)	−0·03	−0·14, 0·07	0·53		–	
Maternal BMI before pregnancy (kg/m^2)	0·02	0·01, 0·03	0·01	0·02	0·01, 0·03	<0·01
Energy intake during pregnancy (MJ/d)	−0·03	−0·07, 0·001	0·06	−0·02	−0·05, 0·01	0·10
Fat intake during pregnancy (energy percentage/d)	0·02	−0·01, 0·05	0·20		–	
Carbohydrate intake during pregnancy (energy percentage/d)	0·02	−0·01, 0·05	0·09	0·01	0·002, 0·02	0·01
Dietary fibre intake during pregnancy (g/MJ per d)	−0·15	−0·22, −0·08	<0·01	−0·15	−0·21, −0·09	<0·01
Folic acid supplementation during pregnancy						
Yes *v.* no (reference)	−0·02	−0·26, 0·23	0·90		–	
Maternal age at intake (years)	−0·03	−0·04, −0·01	<0·01	−0·03	−0·04, −0·01	<0·01
Parity at intake (0–7)	0·22	0·14, 0·30	<0·01	0·22	0·16, 0·29	<0·01
Maternal history of diabetes, hypertension or hypercholesterolaemia at intake						
Yes *v.* no (reference)	0·06	−0·24, 0·35	0·69		–	
Paternal indicators						
Paternal educational background at intake						
Mid *v.* high (reference)	0·11	−0·01, 0·23	0·07	0·16	0·07, 0·25	<0·01
Low *v.* high (reference)	0·23	−0·11, 0·56	0·18	0·41	0·13, 0·70	<0·01
Paternal BMI at intake (kg/m^2)	−0·001	−0·02, 0·01	0·88		–	
Paternal history of diabetes, hypertension or hypercholesterolaemia at intake						
Yes *v.* no (reference)	−0·06	−0·27, 0·15	0·57		–	
Paternal age at intake (years)	−0·01	−0·02, 0·01	0·29	−0·01	−0·02, −0·003	0·01
Paternal smoking at intake						
Yes *v.* no (reference)	0·17	0·06, 0·27	<0·01	0·12	0·03, 0·21	<0·01
Child indicators						
Age of food assessment (months)	0·12	0·10, 0·14	<0·01	0·10	0·08, 0·12	<0·01
Sex						
Female *v.* male (reference)	−0·18	−0·27, −0·08	<0·01	−0·19	−0·26, −0·11	<0·01
Birth weight (standard deviation score)	0·03	−0·03, 0·08	0·29		–	
Breast-feeding in first year of life						
Any partial breast-feeding in first 4 months *v.* never breast-feeding (reference)	−0·08	−0·23, 0·07	0·32		–	
Any full breast-feeding in first 4 months *v.* never breast-feeding (reference)	−0·11	−0·28, 0·08	0·23		–	
Timing of introduction of solids in first year of life ≥6 months *v.* <6 months (reference)	−0·13	−0·23, −0·03	0·02	−0·14	−0·22, −0·05	<0·01
History of food allergy in first year of life						
Yes *v.* no (reference)	−0·17	−0·39, 0·06	0·14	−0·16	−0·33, 0·01	0·07
Daycare or au-pair in first year of life > *v.* ≤16 h/week (reference)	−0·06	−0·18, 0·06	0·33		–	
Weight for age at 14 months (*z*-score)	0·01	−0·07, 0·08	0·82		–	
Height for age at 14 months (*z*-score)	0·02	−0·05, 0·09	0·55	0·04	−0·01, 0·08	0·09
Television watching in second year of life ≥2 h *v.* <2 h/d (reference)	0·32	0·16, 0·47	<0·01	0·33	0·20, 0·46	<0·01

* After using the backward selection procedure with *P*=0·10 as endpoint.
† Difference in factor score of a 'Western-like' diet compared to reference group or per unit of a continuous variable.

Table 4. Predictors of adherence to a 'Health conscious' dietary pattern of children aged 14 months
(Regression coefficients (β) and 95 % confidence intervals, n 2420)

	Multivariate regression (fully adjusted model)			Multivariate regression model after stepwise backward selection*		
	β†	95 % CI	*P*	β	95 % CI	*P*
Maternal indicators						
Maternal educational background at intake						
Mid *v.* high (reference)	−0·02	−0·14, 0·10	0·74		–	
Low *v.* high (reference)	−0·15	−0·62, 0·33	0·55		–	
Household income at intake <2000 euro *v.* ≥2000 euro (reference)	0·02	−0·16, 0·20	0·84		–	
Marital status at intake						
Living alone *v.* married/living together (reference)	0·22	−0·06, 0·51	0·12	0·30	0·07, 0·52	< 0·01
Maternal smoking during pregnancy						
Yes *v.* no (reference)	0·06	−0·09, 0·20	0·47		–	
Maternal alcohol consumption during pregnancy						
Yes *v.* no (reference)	−0·08	−0·19, 0·04	0·18	−0·10	−0·20, −0·01	0·04
Maternal BMI before pregnancy (kg/m^2)	−0·01	−0·02, 0·01	0·33		–	
Energy intake during pregnancy (MJ/d)	0·06	0·02, 0·11	<0·01	0·07	0·03, 0·11	<0·01
Fat intake during pregnancy (energy percentage/d)	−0·02	−0·05, 0·004	0·10		–	
Carbohydrate intake during pregnancy (energy percentage/d)	−0·02	−0·04, 0·004	0·10		–	
Dietary fibre intake during pregnancy (g/MJ per d)	0·13	0·05, 0·20	<0·01	0·14	0·07, 0·21	<0·01
Folic acid supplementation during pregnancy						
Yes *v.* no (reference)	0·26	0·05, 0·47	0·01	0·21	0·03, 0·39	0·02
Maternal age at intake (years)	−0·01	−0·03, 0·01	0·35		–	
Parity at intake (0–7)	−0·03	−0·11, 0·06	0·56		–	
Maternal history of diabetes, hypertension or hypercholesterolaemia at intake						
Yes *v.* no (reference)	−0·13	−0·45, 0·19	0·43	−0·29	−0·57, −0·01	<0·05
Paternal indicators						
Paternal educational background at intake						
Mid *v.* high (reference)	0·15	0·02, 0·28	0·02	0·16	0·03, 0·30	0·02
Low *v.* high (reference)	0·30	−0·06, 0·66	0·10		–	
Paternal BMI at intake (kg/m^2)	−0·001	−0·02, 0·02	0·91		–	
Paternal history of diabetes, hypertension or hypercholesterolaemia at intake						
Yes *v.* no (reference)	−0·14	−0·36, 0·07	0·18		–	
Paternal age at intake (years)	0·001	−0·01, 0·02	0·84		–	
Paternal smoking at intake						
Yes *v.* no (reference)	0·06	−0·06, 0·18	0·33		–	
Child indicators						
Age of food assessment (months)	−0·01	−0·03, 0·02	0·62		–	
Sex female *v.* male (reference)	−0·12	−0·22, −0·01	0·03	−0·11	−0·20, −0·01	0·03
Birth weight (SDS)	0·03	−0·03, 0·09	0·35		–	
Breast-feeding in first year of life						
Any partial breast-feeding in first 4 months *v.* never breast-feeding (reference)	0·05	−0·22, 0·12	0·59		–	
Any full breast-feeding in first 4 months *v.* never breast-feeding (reference)	0·22	0·02, 0·41	0·04	0·18	0·003, 0·36	<0·05
Timing of introduction of solids in first year of life ≥6 months *v.* <6 months (reference)	−0·07	−0·18, 0·05	0·25		–	
History of food allergy in first year of life						
Yes *v.* no (reference)	0·13	−0·12, 0·37	0·31		–	
Daycare or au-pair in first year of life > *v.* ≤16 h/week (reference)	−0·01	−0·16, 0·15	0·95		–	
Weight for age at 14 months (*z*-score)	−0·002	−0·09, 0·09	0·70		–	
Height for age at 14 months (*z*-score)	0·03	−0·05, 0·11	0·51		–	
Television watching in second year of life ≥2 h *v.* <2 h/d (reference)	−0·07	−0·23, 0·10	0·42		–	

SDS, standard deviation score.
* After using the backward selection procedure with $P=0·10$ as endpoint.
† Difference in factor score of a 'Health conscious' diet compared to reference group or per unit of a continuous variable.

maternal macronutrient intake during pregnancy and offspring macronutrient intake[22]. Another study demonstrated that diet quality of 3-year-old children is highly associated with maternal diet quality[44]. The latter association appeared to be independent of other maternal characteristics as BMI and educational level[44], which is in line with our study results since the inverse association between maternal dietary fibre intake and a 'Western-like' dietary pattern of the child was still present after adjusting for maternal BMI and socio-economic background.

Although we did not find a significant association with weight and height *z*-score at 14 months and the dietary patterns, some of the determinants associated with a 'Western-like' dietary pattern have been found to be risk factors of overweight, such as parental smoking, socio-economic background, maternal BMI, maternal diet, early solid-food introduction and TV watching[1,45]. Taking all these into consideration, our study results imply that children with a 'Western-like' dietary pattern might reflect a vulnerable group of children who may be at risk for developing overweight-prone behaviours in later life. Hence, targeting the parents with a low socio-economic background and unfavourable lifestyle factors may be valuable at a very young age of the child to improve the child's eating habits.

Last, we identified a 'Health conscious' dietary pattern within our study population, which was characterised by high consumption of pasta and rice, potatoes, legumes, fruit, vegetables, fish and vegetable oils. In schoolchildren, high adherence to a dietary pattern characterised by fish, legumes, fruits and leafy vegetables has been found to be associated with a better diet quality[46]. However, not much is known about the determinants and effects of a 'Health conscious' dietary pattern in children. Maternal co-morbidity was inversely associated with a 'Health-conscious dietary pattern'. Similarly, we found that other behaviour associated with health awareness of the mother, such as folic acid supplementation, high fibre consumption, no alcohol consumption during pregnancy and full breast-feeding were predictors of adherence to a 'Health conscious' dietary pattern of the child. Strikingly, we found that children of fathers with a mid-educational level had higher scores on the 'Health conscious' dietary pattern relative to children of fathers with high educational level, suggesting that a socio-economic gradient in healthy eating habits may be less straightforward than in unhealthy eating patterns early in life.

In contrast, we also found that children of mothers living alone were more likely to adhere to a 'Health conscious' dietary pattern. We believe that this might have something to do with other socio-demographic factors such as whether both parents are involved in upbringing or which person is responsible for preparation of the meals. In the ALSPAC study, it was demonstrated that cooking performed by a person other than the mother was negatively correlated with a 'Healthy' dietary pattern in 3-year-olds[5]. In addition, when the mother lives together with a partner, unhealthy eating habits of the partner might be more incorporated with the child's diet when the partner is involved in raising the child or the preparation of meals. Unfortunately, we did not have data on paternal dietary habits to further clarify these results.

Several study limitations need to be taken into account to appreciate the results. Although we used the varimax rotation to decrease correlation between the two identified patterns, they still might be intercorrelated to some extent[10,19]. In addition, meat consumption was a correlated factor in both the 'Western-like' and 'Health conscious' dietary patterns in our study group. The identification of dietary patterns in very young children is challenging because dietary patterns may not be strongly formed yet. Also, it cannot be assumed that dietary patterns are perfectly stable throughout early- and mid-childhood as previously demonstrated in ALSPAC[47] and thus, further longitudinal measurements are needed to assess whether unfavourable dietary patterns track during child- and adulthood.

Dietary pattern analysis involves several decisions such as in the division of food items to food groups, the selected method to define these patterns, and the labelling of these components[10], which may have an influence on the final content of the dietary pattern in our study.

The amount of variance (24·5 %) explained by the dietary patterns is small but is similar when compared to previous studies on dietary patterns in young children[5,43]. Nevertheless, this may have consequences on the generalisability of our results in other populations. Therefore, we encourage further study on dietary patterns at this very young age in other populations.

Another limitation of the study is that the FFQ that was used for the collection of maternal nutrition-related data during pregnancy was only validated in an older Dutch population in Rotterdam, the Netherlands[21]. Although we did validate the FFQ of the children against 3 d 24 h recalls, it has been shown that 24 h recalls still underestimate nutrient intake[48]. Unfortunately, we were not able to validate the FFQ against the doubly labelled water method which is considered to be the 'gold standard' to validate total energy intake[48].

Missing data can be an important limitation in cohort studies. We aimed to reduce attrition bias as much as possible. For this reason, we used a multiple imputation procedure, which is a very appropriate method to deal with missing data because it requires the least assumptions and exhibits bias when the missing data are not completely at random[36]. As a result, the 95 % CI in our study reflect the uncertainty associated with the missing values.

We did not have data on the child's preferences, social context of meal consumption and parents' beliefs about nutrition and health. We expect that these factors can be important predictors of a child's adherence to a healthy or unhealthy eating pattern[3]. Therefore, an in-depth study aiming to explore the influence of other social determinants can be worthwhile.

In conclusion, the present study demonstrated that a 'Western-like' dietary pattern can already be present in the second year of the child's life and adherence to this diet is associated with other risk factors for obesity. Targeting parents of these children for health promotion might be useful. Future studies should clarify whether this dietary pattern tracks during child- and adulthood, and which other social determinants predict adherence to a 'Health conscious' dietary pattern in childhood. Finally, the analyses of this study can form a basis for future studies regarding dietary patterns and various health outcomes in this cohort.

British Journal of Nutrition

Acknowledgements

The Generation R Study was conducted by the Erasmus Medical Center in close collaboration with the School of Law and Faculty of Social Sciences of the Erasmus University Rotterdam, the Municipal Health Service–Rotterdam Metropolitan Area, the Rotterdam Homecare Foundation, and the Stichting Trombosedienst & Artsenlaboratorium Rijnmond. The authors acknowledge the contributions of children and parents, general practitioners, hospitals and midwives in Rotterdam. The authors also thank Saskia Meyboom, Corine Perenboom and Els Siebelink of the Department of Human Nutrition, Wageningen University, the Netherlands for their contribution in processing the food consumption data. In the funding phase, the Generation R Study was supported by the Erasmus Medical Center, the Erasmus University Rotterdam, the Netherlands Organization for Health Research and Development (Zon Mw) and Europe Container terminals B.V. The funders had no role in the study design, data collection, data analysis, data interpretation, writing of the report or the decision to submit the manuscript. The authors declare that they have no conflicts of interest. The authors' contributions to this study were as follows: J. C. K.-d. J., H. A. M., J. H. d. V., S. E. B., V. W. V. J., A. H. and H. R. designed the research (project conception, development of overall research plan and study overview); J. C. K.-d. J. and H. A. M. conducted the research (data collection); J. H. d. V. provided essential materials (constructs and databases); J. C. K.-d. J. and H. A. M. analysed the nutritional data and performed statistical analysis; J. C. K.-d. J. wrote the paper; and H. A. M. had primary responsibility for the final content.

References

1. Robinson SM & Godfrey KM (2008) Feeding practices in pregnancy and infancy: relationship with the development of overweight and obesity in childhood. *Int J Obes* **32**, Suppl. 6, S4–S10.
2. Ells LJ, Campbell K, Lidstone J, *et al.* (2005) Prevention of childhood obesity. *Best Pract Res Clin Endocrinol Metab* **19**, 441–454.
3. Patrick H & Nicklas TA (2005) A review of family and social determinants of children's eating patterns and diet quality. *J Am Coll Nutr* **24**, 83–92.
4. Skinner JD, Carruth BR, Bounds W, *et al.* (2002) Do food-related experiences in the first 2 years of life predict dietary variety in school-aged children? *J Nutr Educ Behav* **34**, 310–315.
5. North K & Emmett P (2000) Multivariate analysis of diet among three-year-old children and associations with socio-demographic characteristics. The Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC) Study Team. *Eur J Clin Nutr* **54**, 73–80.
6. Aranceta J, Perez-Rodrigo C, Ribas L, *et al.* (2003) Sociodemographic and lifestyle determinants of food patterns in Spanish children and adolescents: the enKid study. *Eur J Clin Nutr* **57**, Suppl. 1, S40–S44.
7. van Rossem L, Oenema A, Steegers EA, *et al.* (2009) Are starting and continuing breastfeeding related to educational background? The Generation R study. *Pediatrics* **123**, e1017–e1027.
8. Schiess S, Grote V, Scaglioni S, *et al.* (2010) Introduction of complementary feeding in 5 European countries. *J Pediatr Gastroenterol Nutr* **50**, 92–98.
9. Hoffmann K, Schulze MB, Schienkiewitz A, *et al.* (2004) Application of a new statistical method to derive dietary patterns in nutritional epidemiology. *Am J Epidemiol* **159**, 935–944.
10. Hu FB (2002) Dietary pattern analysis: a new direction in nutritional epidemiology. *Curr Opin Lipidol* **13**, 3–9.
11. Kjollesdal MR, Holmboe-Ottesen G, Mosdol A, *et al.* (2010) The relative importance of socioeconomic indicators in explaining differences in BMI and waist:hip ratio, and the mediating effect of work control, dietary patterns and physical activity. *Br J Nutr* **104**, 1230–1240.
12. Paradis AM, Godin G, Perusse L, *et al.* (2005) Associations between dietary patterns and obesity phenotypes. *Int J Obes (Lond)* **33**, 1419–1426.
13. Kant AK (2010) Dietary patterns: biomarkers and chronic disease risk. *Appl Physiol Nutr Metab* **35**, 199–206.
14. Jaddoe VW, van Duijn CM, van der Heijden AJ, *et al.* (2010) The Generation R Study: design and cohort update 2010. *Eur J Epidemiol* **25**, 823–841.
15. Feunekes GI, Van Staveren WA, De Vries JH, *et al.* (1993) Relative and biomarker-based validity of a food-frequency questionnaire estimating intake of fats and cholesterol. *Am J Clin Nutr* **58**, 489–496.
16. Hulshof K & Breedveld B (2002) *Results of the Study on Nutrient Intake in Young Toddlers* 2002. Zeist: TNO Nutrition.
17. Donders-Engelen M, Heijden van der L & Hulshof KF (2003) *Maten, gewichten en codenummers*. Wageningen: Human Nutrition of TNO and Wageningen University.
18. Netherlands Nutrition Center (2006) *Nevo: Dutch food composition database* 2006. The Hague: Netherlands Nutrition Centre.
19. Tucker KL (2010) Dietary patterns, approaches, and multicultural perspective. *Appl Physiol Nutr Metab* **35**, 211–218.
20. Swertz O, Duimelaar P & Thijssen J (2004) *Migrants in the Netherlands* 2004. Voorburg/Heerlen: Statistics Netherlands.
21. Klipstein-Grobusch K, den Breeijen JH, Goldbohm RA, *et al.* (1998) Dietary assessment in the elderly: validation of a semiquantitative food frequency questionnaire. *Eur J Clin Nutr* **52**, 588–596.
22. Brion MJ, Ness AR, Rogers I, *et al.* (2010) Maternal macronutrient and energy intakes in pregnancy and offspring intake at 10 y: exploring parental comparisons and prenatal effects. *Am J Clin Nutr* **91**, 748–756.
23. Willett WC, Howe GR & Kushi LH (1997) Adjustment for total energy intake in epidemiologic studies. *Am J Clin Nutr* **65**, 4 Suppl., 1220S–1228S, discussion 9S–31S.
24. Hu FB, Stampfer MJ, Rimm E, *et al.* (1999) Dietary fat and coronary heart disease: a comparison of approaches for adjusting for total energy intake and modeling repeated dietary measurements. *Am J Epidemiol* **149**, 531–540.
25. Statistics Netherlands (2004) *Dutch Standard Classification of Education* 2003. Voorburg/Heerlen: Statistics Netherlands.
26. World Heatlh Organization (2002) Global Strategy for Infant and Young Child Feeding. Unicef. 2002. http://www.who.int/nutrition/publications/infantfeeding/9241562218/en/index.html
27. American Academy of Pediatrics (2001) Committee on Public E. American Academy of Pediatrics: children, adolescents, and television. *Pediatrics* **107**, 423–426.
28. Fredriks AM, van Buuren S, Burgmeijer RJ, *et al.* (2000) Continuing positive secular growth change in The Netherlands 1955–1997. *Pediatr Res* **47**, 316–323.

29. Kaiser H (1958) The varimax criterion for analytic rotation in factor analysis. *Psychometrika* **23**, 14.
30. Hatcher L (1997) *A Step-by-Step Approach to Using the SAS System for Factor Analysis and Structural Equation Modeling*. Cary, NC: SAS Institute, Inc.
31. Gubbels JS, Kremers SP, Stafleu A, *et al.* (2009) Clustering of dietary intake and sedentary behavior in 2-year-old children. *J Pediatr* **155**, 194–198.
32. Brekke HK, van Odijk J & Ludvigsson J (2007) Predictors and dietary consequences of frequent intake of high-sugar, low-nutrient foods in 1-year-old children participating in the ABIS study. *Br J Nutr* **97**, 176–181.
33. Christie L, Hine RJ, Parker JG, *et al.* (2002) Food allergies in children affect nutrient intake and growth. *J Am Diet Assoc* **102**, 1648–1651.
34. Hendricks K, Briefel R, Novak T, *et al.* (2006) Maternal and child characteristics associated with infant and toddler feeding practices. *J Am Diet Assoc* **106**, 1 Suppl. 1, S135–S148.
35. Dott M, Rasmussen SA, Hogue CJ, *et al.* (2010) Association between pregnancy intention and reproductive-health related behaviors before and after pregnancy recognition, National Birth Defects Prevention Study, 1997–2002. *Matern Child Health J* **14**, 373–381.
36. Sterne JA, White IR, Carlin JB, *et al.* (2009) Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. *BMJ* **338**, b2393.
37. Rubin DB & Schenker N (1991) Multiple imputation in health-care databases: an overview and some applications. *Stat Med* **10**, 585–598.
38. Libuda L, Alexy U, Buyken AE, *et al.* (2009) Consumption of sugar-sweetened beverages and its association with nutrient intakes and diet quality in German children and adolescents. *Br J Nutr* **101**, 1549–1557.
39. Collison KS, Zaidi MZ, Subhani SN, *et al.* (2010) Sugar-sweetened carbonated beverage consumption correlates with BMI, waist circumference, and poor dietary choices in school children. *BMC Public Health* **10**, 234.
40. Demory-Luce D, Morales M, Nicklas T, *et al.* (2004) Changes in food group consumption patterns from childhood to young adulthood: the Bogalusa Heart Study. *J Am Diet Assoc* **104**, 1684–1691.
41. Kleber M, Schwarz A & Reinehr T (2011) Obesity in children and adolescents: relationship to growth, pubarche, menarche, and voice break. *J Pediatr Endocrinol Metab* **24**, 125–130.
42. Coon KA, Goldberg J, Rogers BL, *et al.* (2001) Relationships between use of television during meals and children's food consumption patterns. *Pediatrics* **107**, E7.
43. Robinson S, Marriott L, Poole J, *et al.* (2007) Dietary patterns in infancy: the importance of maternal and family influences on feeding practice. *Br J Nutr* **98**, 1029–1037.
44. Fisk CM, Crozier SR, Inskip HM, *et al.* (2011) Influences on the quality of young children's diets: the importance of maternal food choices. *Br J Nutr* **105**, 287–296.
45. Beyerlein A, Toschke AM & von Kries R (2010) Risk factors for childhood overweight: shift of the mean body mass index and shift of the upper percentiles: results from a cross-sectional study. *Int J Obes (Lond)* **34**, 642–648.
46. Lazarou C, Panagiotakos DB & Matalas AL (2003) Level of adherence to the Mediterranean diet among children from Cyprus: the CYKIDS study. *Public Health Nutr* **12**, 991–1000.
47. Northstone K & Emmett PM (2008) Are dietary patterns stable throughout early and mid-childhood? A birth cohort study. *Br J Nutr* **100**, 1069–1076.
48. Kipnis V, Subar AF, Midthune D, *et al.* (2003) Structure of dietary measurement error: results of the OPEN biomarker study. *Am J Epidemiol* **158**, 14–21, discussion 2–6.