Public Health Nutrition: 20(5), 870–882 doi:10.1017/S1368980016002895

Socio-economic disparities in the diet of French children and adolescents: a multidimensional issue

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Submitted 21 March 2016: Final revision received 6 September 2016: Accepted 16 September 2016: First published online 16 November 2016

Abstract

Objective: The present research aimed to study the multidimensionality of the link between dietary intake and socio-economic position (SEP) in a representative sample of French children and adolescents, using a variety of SEP indicators.
Design: Data from the second French national food consumption survey (INCA2) were used. Information on food consumption was collected using a 7 d food record and SEP data (occupation, education, income, household wealth indices) using questionnaires. Multivariable linear regression analyses were performed separately in children and adolescents to assess the relationships between dietary components (food groups and macronutrients) and each dimension of SEP.
Setting: The INCA2 survey, France.
Subjects: A representative sample of French children (3–10 years of age; *n* 574) and adolescents (11–17 years of age; *n* 881).
Results: Compared with children from a higher SEP, those from a lower SEP had lower intakes of fruit and vegetables, yoghurts and confectionery and higher intakes of starchy foods, meat, milk, sugar-sweetened beverages and pizzas/sandwiches. Similar results were observed in adolescents for fruit and vegetables, yoghurts and sugar-sweetened beverages. Adolescents also had lower intakes of cakes/pastries and higher intakes of processed meat and dairy desserts. Neither energy nor protein intake was associated with SEP. Adolescents from a lower SEP had higher carbohydrate and lower lipid intakes. Overall, these findings were consistent across the various dimensions of SEP, but the gradient was steeper depending on the caregiver's educational level.
Conclusions: This research highlights the need for specific messages to help poorly educated families adopt good eating habits.

Keywords
Diet
Fruit and vegetables
Sugar-sweetened beverages
Energy intake
Socio-economic position
French children

The major determinants of children's diet studied so far are embedded at different levels of the socio-ecological model[1]. They include environmental factors such as accessibility, availability and parental attitudes; socio-economic factors such as household income and parents' occupational status; cultural factors such as parental education, beliefs, habits and tradition; psychosocial factors such as conviviality and family meals; and finally individual factors such as age, gender, taste, food preferences and specific physiological needs related to growth[2,3].

It has been shown that children and adolescents from a low socio-economic position (SEP) are more likely to have suboptimal diets[4,5], characterised by low intakes of fruit and vegetables (F&V), fish or dairy products and high intakes of snacks or sugar-sweetened beverages (SSB). It has been suggested that such diets contribute to low micronutrient intakes[6–9] and high energy and fat intakes[9,10]. In France, only two national studies have analysed relationships between diet and SEP in school-aged children and adolescents: the Nutrition and Health Survey (ENNS)[11] and the Individual and National Food Consumption Surveys (INCA1 and INCA2)[12]. Data from

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the ENNS suggested that children from a low SEP (defined on the basis of both head of the household's educational level and occupational status) had a lower intake of F&V. In children from the INCA1 survey, the head of the household's low occupational status was positively associated with the 'snacking and sedentary pattern' partly characterised by high consumption of French fries and sweetened beverages and low consumption of dairy products; and inversely associated with the 'varied food and physically active pattern' partly characterised by high consumption of vegetables and dairy products[13]. Using parental education as an indicator of SEP, similar trends were observed in 3- to 17-year-old participants of the INCA2 survey, with a positive social gradient observed for core foods such as dairy products and F&V and an inverse gradient observed for non-core foods such as savoury snacks and meat products[12].

It has been suggested that an energy-dense, nutrient-poor diet increases the risk of chronic diseases such as obesity, CVD and cancer[14]. Socio-economic disparities in diet starting from childhood could therefore partly explain socio-economic inequalities in health later in life[15]. Public health policies therefore face the major challenge of improving the diet of the whole population. In France, nutritional and food policies have been implemented since 2001, including the National Nutrition and Health Programme (PNNS) and the National Programme for Food (PNA). Several of the initial objectives have been partially or fully achieved[16], such as the stabilisation of the prevalence of overweight and obese children, a reduced consumption of sugar and salt, and the increase in adults' fruit consumption. However, these improvements have not been spread evenly over all population groups, thus increasing social inequalities in health. The PNNS was updated in 2011, the main focus being the reduction of 'nutrition-related health inequalities between social classes through specific actions'. Besides, the PNA launched in 2010 aims to ensure food security by providing access to suitable food in adequate quantities to everyone. The Food and Insertion Programme, renewed every year since 2003, also includes actions to promote nutritional balance and the prevention of nutritional deficiency in disadvantaged population groups.

Different indicators have been used to study the relationship between SEP and dietary intakes, but there is no consensus so far on the most relevant indicator to measure SEP in nutritional epidemiology. While educational level, income and, to a lesser extent, occupational status have most often been used, new integrative approaches have been developed to measure the household's wealth by taking into account various characteristics, such as equipment, housing occupation status and how the financial situation is perceived[17–19]. The SEP indicator chosen is important as the relationship of SEP with diet is likely to differ according to both the particular SEP dimension and the dietary item under study[20,21]. A recent article by Zarnowiecki *et al.*[22] thus suggested using multiple indicators to analyse relationships between SEP and dietary intake in order to assess the influence of SEP on diet more comprehensively and to identify the most appropriate action levers for prevention.

The aim of the present study was to examine the associations between a variety of SEP indicators and both dietary and macronutrient intakes in a representative sample of children and adolescents aged 3 to 17 years living in France.

Materials and methods

Data from the cross-sectional French INCA2 national food consumption survey, carried out between December 2005 and May 2007 by the French Food Safety Agency (AFSSA), were used in the analysis. The survey was approved by the French Data Protection Authority (CNIL).

Population

The INCA2 survey was designed primarily to assess dietary intake in a nationally representative sample of French people. Two independent random samples of 3- to 17-year-old children and 18- to 79-year-old adults were defined on the basis of a multistage stratified sampling design. The sampling frame was extracted from the national census published by the French National Institute of Statistics and Economic Studies (INSEE). First, 181 primary geographical units, stratified by region of residence and size of urban area, were randomly selected with probability proportional to size. Next, households were randomly selected from each primary unit and two independent sampling frames were set up: the first, restricted to households including at least one child; and the second, including households with or without children. Lastly, within each household, either a child or an adult was randomly selected. The sampling design is described in more detail elsewhere[23]. A participation rate of 69 % was obtained for children and adolescents, yielding a sample of 1455 participants aged 3–17 years.

Measurements

Dietary and macronutrient intakes

Dietary intake was assessed using an open-ended 7 d food record delivered by a trained and certified investigator who explained to the parents and their child how to complete the record. Children aged 10 years or younger were helped by their parents or caregivers to fill it out. Participants were asked to describe all food and beverage intakes over seven consecutive days. They estimated portion size using the SU.VI.MAX (Supplémentation en Vitamines et Minéraux AntioXydants) photographic booklet[24] or expressed intakes by weight or household measures.

Dietary intake (in grams per day) was assessed based on the 7 d food record. Food groups were defined consistent with French recommendations (PNNS): vegetables and fruit (including fresh and dried fruit and fruit juices), starchy foods (bread, pasta, rice, potatoes, legumes and other cereals), meat/fish/eggs (meat includes offal and processed meat; fish includes crustaceans), dairy products (milk and dairy drinks, yoghurts and cheese) and SSB (nectars, soft fruit drinks and soda). Other groups considered separately included dairy desserts, cakes and pastries, confectionery, pizzas/sandwiches and stewed fruit/fruit in syrup. The latter were not included in the fruit subgroup because they often contain added sugar and only stewed fruit without added sugar should be considered as fruit according to the PNNS guidelines.

Macronutrient intakes (in kilocalories or grams per day) were evaluated using the French food composition tables[25,26]. Nusser *et al.* proposed a statistical method (semi-parametric transformation) to estimate usual long-term intakes from intakes observed over a short period[27]. These usual intakes are a better estimation at population scale. They were estimated for the INCA2 study with MSM (Multiple Source Method) software developed by the German Institute of Human Nutrition[28]. As this calculation needs the same number of days for each participant's food record, we excluded seventy-three children who filled out the food record for fewer than 7 d.

Indicators of socio-economic position

A face-to-face questionnaire was also administered to the adult caregiver. It included various SEP characteristics such as occupational status and educational level of the adult caregiver (the mother in 80 % of cases) in addition to household income. The following household wealth characteristics were also reported: 'having gone away on holiday for more than 4 consecutive days within the last 12 months' (yes/no), 'number of cars in the household', 'number of domestic electrical appliances', 'how the financial situation is perceived' (positively/negatively), 'financial access to desired food products' (yes/no), 'whether the idea of lacking food would be a concern' (yes/no), 'giving up health care for financial reasons' (yes/no) and 'housing occupation status' (first-time buyer/owner/tenant/tenant in social housing and others).

Five different SEP indicators were used for the current study: the occupational status and educational level of the adult caregiver, the household's income per consumption unit (ICU), a household wealth composite index and a global SEP composite index which synthesised the previous four indicators. Occupational status was divided into four categories: 'low' (unemployed and manual workers), 'intermediate' (middle professions and farmers), 'high' (executive, top management and professional categories) and 'inactive' (retired, homemakers and students). Educational level was divided into three categories: 'low' was assigned to those without any qualifications (mid-secondary or below), 'intermediate' to secondary school level and 'high' to higher education (undergraduate and postgraduate). The ICU was calculated as the income corrected for household size. As 20 % of values were missing, simple regression imputation was used to complete missing income data through the Kohonen algorithm with R software[29,30]. First, homogeneous clusters of individuals were identified using a range of variables (such as sex, educational level and the variables used to define household wealth); then individuals with a missing value for income were assigned the income of a randomly chosen individual within the same cluster. The ICU was calculated as recommended by INSEE[31]: the household income was divided by the weighted sum of the number of adult and child household members. The most widely used scale, the OECD (Organisation for Economic Co-operation and Development) scale, uses the following weighting: 1·0 for the first adult in the household, 0·5 for all other members aged 14 years or over and 0·3 for children under the age of 13 years. The ICU was then divided into tertiles corresponding to the following thresholds: <725, 725 to <1330 and ≥1330 €/month per consumption unit.

Composite SEP indices were the first components derived from two correspondence analyses performed on the matrix of indicator variables coding SEP characteristics, consistent with previous studies based on the INCA2 study[17,32]. Briefly, the household wealth composite index was constructed taking into account all the measures of wealth previously described. The global SEP composite index was derived from occupational status, educational level, ICU and all the variables also used to define household wealth. In each correspondence analysis, the score of each participant for the first principal component was used as the summary index since it explained about 80 % of the variability. The variables that contributed most to the construction of the two scores were the financial aspects (access to desired food products, fear of lacking food, giving up health care for financial reasons, perception of financial situation) as well as the ICU for the global SEP index. Each score was then divided into tertiles representing low-, intermediate- and high-score groups. Composite indices and tertiles were estimated for the entire population (3- to 17-year-olds) in order to ensure comparability in analyses on children and adolescents.

Statistical analysis

All analyses were conducted using the statistical software package SAS version 9.3. The INCA2 data were weighted for unequal sampling probabilities and for differential non-responses by region, agglomeration size, household size, age, gender, occupation of the household head and season. The complex design of the survey was taken into account using appropriate procedures (survey). The critical P value was set at $P = 0{\cdot}05$.

All the analyses were stratified by age, so performed separately for children (3–10 years old; n 574) and adolescents (11–17 years old; n 881). Associations between each of the five SEP indicators and both dietary and macronutrient intakes were tested using multivariable linear regression analyses adjusted for age, gender and energy intake.

Results

The characteristics of the studied sample are provided in Table 1. Children and adolescents were on average aged 7 and 14 years, respectively, with about half of each group made up of girls. Children's caregivers tended to have a higher level of education than adolescents' caregivers. Regarding occupational status, there was a proportionally higher number of inactive caregivers among adolescents than among children.

Socio-economic disparities in dietary intakes

In children aged 3–10 years

As shown in Table 2, children from a lower SEP (lower educational level, ICU or global SEP index) had a lower intake of F&V (with a difference from the higher to lower SEP categories ranging from −39 to −75 g/d depending on the SEP indicator). Within the F&V group, vegetable intake was more strongly associated with SEP (with a difference ranging from −29 to −41 g/d depending on the SEP indicator). Similarly, children from a lower SEP had a lower intake of stewed fruit/fruit in syrup (significant for all the SEP indicators).

Children from a low SEP (lower ICU, household wealth index and global SEP index) also had a higher intake of starchy foods, with differences ranging from + 12 to +15 g/d depending on the SEP indicator. Among starchy foods, pasta intake was more strongly associated with SEP (in particular educational level, ICU and global SEP index, attaining a difference of 22 g/d with educational level).

Children from a low SEP (lower occupational status, educational level or global SEP index) had a higher intake of items from the 'meat/fish/egg' food group. Differences ranged from +11 to +16 g/d depending on the SEP indicator and were mostly driven by meat intake. Fish intake was not significantly associated with any of the SEP indicators.

In contrast to the overall intake of dairy products, the type of dairy products consumed differed according to SEP. Children from lower SEP had a higher intake of milk (significant associations observed with household wealth and the global SEP index) and a lower intake of yoghurt (significant across all the SEP indicators except ICU).

Children from lower SEP (lower ICU, household wealth index or global SEP index) drank almost twice as much SSB than children from higher SEP (differences ranging from +20 to +45 g/d depending on the SEP indicator).

Table 1 Characteristics of the study sample of children and adolescents from the second French national food consumption survey (INCA2), 2006–2007

	Children (n 574)		Adolescents (n 881)		
	Mean or %	SD	Mean or %	SD	P value*
Mean age (years)	7·0	0·1	14·1	0·1	<0·001
Sex (% female)	47·0	2·1	50·0	2·2	0·33
Educational level of adult caregiver (%)					
Low	10·9	1·4	16·2	1·8	0·001
Intermediate	53·3	2·2	57·6	2·1	
High	35·8	2·1	26·3	1·8	
Occupational status of the adult caregiver (%)					
Low	50·4	2·1	39·9	2·1	<0·001
Intermediate	29·5	2·0	27·2	1·6	
High	18·1	1·6	18·9	1·5	
Inactive	2·0	0·7	14·0	2·5	
Income per consumption unit (%)					
<€725/month	32·8	2·3	32·6	2·3	0·78
€725–1330/month	31·2	2·1	33·1	1·9	
≥€1330/month	36·0	2·0	34·3	2·1	
Household wealth index (%)					
Low	34·8	2·0	31·0	1·9	0·06
Intermediate	36·0	1·9	32·9	2·3	
High	29·2	1·9	36·1	2·3	
Global SEP index (%)					
Low	35·0	2·0	32·6	2·5	0·29
Intermediate	29·5	1·7	34·1	2·2	
High	35·5	2·1	33·3	2·0	

SEP, socio-economic position.
*Student's t test for age; Rao–Scott χ^2 test for percentages.

Table 2 Mean food intakes (and standard deviations), in grams per day, according to five indicators of socio-economic position (SEP) in children aged 3–10 years from the second French national food consumption survey (INCA2), 2006–2007*

	Occupational status†									Educational level‡							Income per consumption unit§							Household wealth index§							Global SEP index§						
	C1 (*n* 265)		C2 (*n* 138)		C3 (*n* 50)		C4 (*n* 121)			C1 (*n* 70)		C2 (*n* 298)		C3 (*n* 204)			T1 (*n* 199)		T2 (*n* 178)		T3 (*n* 197)			T1 (*n* 208)		T2 (*n* 206)		T3 (*n* 158)			T1 (*n* 205)		T2 (*n* 171)		T3 (*n* 179)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*P*	Mean	SD	Mean	SD	Mean	SD	*P*	Mean	SD	Mean	SD	Mean	SD	*P*	Mean	SD	Mean	SD	Mean	SD	*P*	Mean	SD	Mean	SD	Mean	SD	*P*
F&V	243·8	10·6	264·2	12·3	270·3	14·4	256·0	19·4	0·20	211·2	24·0	237·2	10·0	285·9	10·3	0·001	236·7	15·0	246·6	10·9	275·8	11·2	0·05	235·0	14·2	255·1	14·4	274·6	13·2	0·07	232·5	12·6	258·1	16·1	276·5	11·0	0·02
Vegetables	108·4	5·1	117·8	6·6	115·5	10·1	108·9	11·2	0·67	85·6	8·8	105·2	4·5	126·1	6·3	<0·001	101·2	5·6	111·0	5·5	121·2	7·0	0·07	99·2	4·8	108·4	5·5	129·3	8·5	0·009	97·1	5·0	114·4	5·7	125·6	7·8	0·004
Fruit	135·4	8·1	146·4	9·9	154·8	8·2	147·1	12·6	0·26	126·2	18·0	132·0	8·4	159·8	7·2	0·03	135·5	12·2	135·7	8·9	154·6	6·9	0·17	135·8	9·6	146·8	11·4	145·2	9·0	0·54	135·4	10·0	143·7	14·3	151·0	7·3	0·43
Starchy foods	152·7	3·5	152·7	3·1	152·3	7·4	154·7	6·4	0·99	174·0	9·0	150·4	3·6	151·4	3·5	0·07	159·3	4·9	157·2	3·7	143·9	3·3	0·01	157·0	4·9	156·2	3·9	143·9	3·3	0·02	157·5	5·0	156·2	4·3	145·2	3·1	0·04
Bread	42·4	2·2	48·1	2·5	44·7	3·3	40·8	3·6	0·35	40·8	3·1	42·4	2·1	46·0	2·0	0·22	41·9	2·4	47·3	2·9	42·1	1·9	0·27	41·8	2·3	45·4	2·7	43·9	3·0	0·52	40·9	2·3	47·2	2·9	44·0	2·4	0·16
Pasta	37·9	2·0	33·3	1·9	31·3	4·7	34·5	3·5	0·20	52·3	6·0	35·9	1·8	30·6	2·0	<0·001	37·2	2·7	38·6	2·4	31·1	2·1	0·03	40·2	3·2	34·8	1·9	30·8	2·0	0·06	39·5	2·9	35·5	2·1	30·5	1·9	0·01
Rice	18·0	1·6	19·0	1·6	22·6	4·0	23·7	2·8	0·22	21·0	4·5	18·4	1·2	21·6	2·2	0·44	21·0	1·8	18·4	2·1	20·3	1·7	0·53	20·1	1·5	18·8	1·8	20·4	2·9	0·77	20·3	1·6	18·3	1·7	20·6	2·6	0·60
Potatoes	46·4	1·9	47·2	3·0	48·1	5·7	45·4	3·6	0·96	51·5	3·0	46·1	2·3	45·9	3·0	0·35	50·7	3·0	45·0	2·2	44·0	2·3	0·11	46·7	2·7	48·9	3·0	43·0	2·3	0·21	48·8	2·7	46·8	3·0	44·0	2·7	0·42
Legumes	7·6	1·0	4·9	1·0	5·5	1·9	9·8	1·2	0·01	8·2	1·6	7·3	0·8	7·0	0·8	0·80	8·2	1·2	7·4	1·4	6·3	0·8	0·34	7·9	1·0	7·9	1·0	5·5	1·1	0·19	7·6	0·9	7·9	1·1	6·0	0·8	0·29
Meat/fish/eggs	106·4	3·2	106·2	3·7	94·3	4·7	98·7	3·5	0·04	115·6	5·7	104·4	2·3	99·6	2·5	0·04	105·6	3·7	103·9	2·5	101·3	2·5	0·58	108·1	3·1	101·5	2·6	100·4	2·9	0·16	107·2	3·3	106·7	3·1	96·6	2·4	0·008
Meat	75·9	2·4	74·6	3·1	65·9	3·8	72·5	3·9	0·20	81·1	5·8	76·0	1·9	69·5	2·4	0·04	75·8	3·0	72·3	3·1	73·6	2·5	0·75	74·9	2·6	73·8	2·9	72·2	2·6	0·77	74·7	3·0	77·7	2·8	68·5	2·2	0·03
Processed meat	24·4	1·3	22·1	1·6	13·4	2·1	22·3	2·1	0·21	22·6	3·1	25·3	1·2	19·9	1·4	0·01	23·3	1·6	23·0	1·6	22·6	1·5	0·94	23·8	1·4	23·9	1·5	20·7	1·7	0·20	24·1	1·5	24·1	1·7	20·4	1·4	0·08
Fish	19·2	1·4	20·4	1·5	18·9	1·8	18·7	1·9	0·84	20·9	3·4	18·5	1·0	20·0	1·4	0·66	21·0	1·6	18·3	1·0	18·7	1·4	0·33	20·9	1·6	17·8	1·1	19·5	1·3	0·16	20·8	1·6	18·5	1·1	18·9	1·3	0·44
Eggs	11·4	1·3	11·2	1·4	9·5	1·4	7·6	1·3	0·07	13·6	3·3	9·9	1·0	10·1	0·9	0·52	8·9	1·0	13·3	1·8	9·0	0·8	0·07	12·3	1·1	9·9	1·2	8·7	0·9	0·04	11·7	1·2	10·5	1·4	9·2	0·9	0·25
Dairy products	313·6	9·7	298·0	16·6	361·7	36·7	307·2	18·9	0·47	310·0	20·3	313·4	9·4	312·9	15·0	0·98	316·4	10·3	311·2	16·8	311·5	14·8	0·95	332·7	12·8	285·1	12·3	324·4	15·6	0·002	321·2	13·6	307·2	11·6	312·2	17·6	0·69
Milk	214·5	8·7	194·2	13·9	228·0	27·8	206·3	15·4	0·66	226·9	17·2	211·8	8·3	200·7	12·1	0·35	222·5	10·9	206·9	12·8	198·8	10·9	0·28	241·9	12·3	181·2	9·2	204·7	13·8	<0·001	233·3	12·5	197·5	11·6	196·6	12·4	0·04
Yoghurts	81·7	4·4	83·1	6·2	116·6	12·5	82·6	6·7	0·02	67·6	10·1	83·6	5·0	92·6	5·6	0·02	76·5	5·6	87·2	8·1	92·3	7·3	0·25	73·3	4·3	86·9	8·3	98·6	6·3	0·002	71·8	4·6	90·3	5·7	95·9	8·5	0·004
Cheese	17·4	0·9	20·7	1·7	17·1	1·8	18·3	2·2	0·42	15·5	1·7	18·0	1·0	19·5	1·3	0·19	17·4	1·5	17·1	1·1	20·4	1·4	0·15	17·5	1·4	17·0	1·0	21·1	1·7	0·09	16·1	1·2	19·5	1·4	19·8	1·5	0·12
SSB	100·7	10·6	69·4	8·6	62·7	12·9	74·8	10·2	0·07	76·4	13·4	95·3	7·5	71·7	9·3	0·11	86·6	7·3	100·9	14·4	66·9	7·5	0·04	94·3	10·2	99·5	11·3	49·8	7·1	<0·001	98·3	10·9	90·9	11·5	57·8	6·6	<0·001
Other products																																					
Stewed fruit/fruit in syrup	18·4	1·6	27·3	3·2	20·7	3·2	22·9	3·8	0·04	13·9	2·9	19·7	2·1	26·0	2·2	0·002	16·7	1·9	23·4	2·7	24·8	2·3	0·01	17·6	1·8	21·8	3·3	26·8	4·1	0·03	17·4	1·9	18·5	2·4	28·9	3·1	0·02
Dairy desserts	33·8	2·6	30·0	2·8	32·8	4·8	26·9	3·6	0·46	36·8	7·1	30·9	2·2	30·4	2·7	0·69	26·5	3·0	32·0	2·9	35·2	2·4	0·07	31·6	2·6	32·4	2·7	29·9	2·7	0·78	34·0	3·1	29·6	2·7	30·5	2·6	0·57
Cakes/pastries	66·5	2·8	66·7	3·9	70·4	3·1	67·3	4·0	0·78	62·7	4·8	65·9	2·3	69·8	3·0	0·44	65·6	3·2	64·2	2·9	71·0	2·9	0·25	63·6	2·6	67·1	2·7	71·8	3·3	0·13	64·7	2·9	64·8	3·9	72·9	2·8	0·08
Confectionery	18·2	1·0	20·2	1·3	21·9	1·6	20·3	1·5	0·17	13·7	1·3	18·6	0·9	22·0	1·0	<0·001	16·0	1·1	20·7	1·3	21·5	1·0	0·002	16·0	0·9	20·6	1·2	22·3	1·5	<0·001	16·6	1·0	18·1	1·3	23·5	1·4	<0·001
Pizza/sandwiches	24·4	1·7	18·9	2·4	17·4	1·8	25·0	3·1	0·009	25·9	3·6	25·4	1·9	18·1	1·8	0·01	26·0	2·7	23·2	1·8	18·9	1·9	0·07	27·5	2·0	21·9	2·6	17·3	2·0	0·001	28·8	2·5	21·6	2·0	17·2	2·0	<0·001

F&V, fruit and vegetables; SSB, sugar-sweetened beverages.
*Mean intake (SD) adjusted for age, gender and energy intake·
†Categories for occupational status: C1, low; C2, intermediate; C3, high; C4, inactive.
‡Categories for educational level: C1, low; C2, intermediate; C3, high.
§Tertiles for the household wealth index, the global SEP index and the income per consumption unit: T1, <€725/month; T2, €725–1330/month, T3, ≥€1330/month.

They also had a higher intake of pizzas/sandwiches (significant across all SEP indicators except ICU) and a lower intake of confectionery (significant across all SEP indicators except occupational status).

Educational level was the SEP indicator most often and strongly associated with dietary intakes.

In adolescents aged 11–17 years

As shown in Table 3, adolescents from lower SEP (lower educational level or household wealth index) had a lower intake of F&V (differences ranging from −45 to −72 g/d depending on the SEP indicator). In contrast to children, vegetable intake was not, however, associated with any of the SEP indicators. The contrary was observed for fruit intake (differences ranging from −24 to −55 g/d across all SEP indicators).

The consumption of starchy foods was not associated with SEP.

Adolescents from lower SEP (lower occupational status, educational level or global SEP index) had a higher intake of processed meat, but no such association was observed with any other item in the 'meat/fish/egg' group, nor with this group considered as a whole.

Total dairy product intake was not significantly associated with SEP. However, within this group, yoghurt intake was positively associated with SEP (all SEP indicators except occupational status).

Adolescents from a low SEP (lower educational level, household wealth index and global SEP index) had a higher intake of SSB, with differences ranging from +47 to +92 g/d depending on the SEP indicator. They also had a higher intake of dairy desserts (significant association with occupational status and educational level) and a lower intake of cakes and pastries (significant association with occupational status and global SEP index).

Educational level was the SEP indicator most often and strongly associated with dietary intake in adolescents.

Socio-economic disparities in macronutrient intakes

In children aged 3–10 years

As shown in Table 4, there was no association between SEP and the intake of total energy, protein, carbohydrate or lipid. There were, however, differences in sugar (simple carbohydrate) and starch (complex carbohydrate) intakes. On the one hand, children from lower SEP (all indicators) had a significantly lower intake of sugar. On the other hand, they had a significantly higher intake of starch (significant associations with educational level and ICU). The largest differences were observed with educational level.

In adolescents aged 11–17 years

As shown in Table 5, neither total energy intake nor protein intake was associated with SEP. Adolescents from lower SEP (lower occupational status or educational level) did, however, have a higher carbohydrate intake, which was essentially driven by higher intake of starch (significant across all the SEP indicators). Adolescents from lower SEP (lower occupational status, educational level or global SEP index) had a lower lipid intake, which was attributable to differential intakes of both MUFA and SFA.

Discussion

The present study is the first in France to study the multidimensionality of the association between SEP and both dietary and macronutrient intakes in school-aged children and adolescents using comprehensive SEP indicators, thus providing important insights into the most appropriate action levers to use within nutritional policies.

Consistent with other studies, our findings confirm both the lower intake of F&V[6,8–11,33–35] (in particular vegetables in school-aged children and fruit in adolescents) and the higher intake of SSB[6,18,34–37] in lower SEP backgrounds. The maximum differences observed between lower and higher SEP categories were equivalent to one 80 g portion of F&V per day and 90 ml of SSB per day, which are equivalent to five fruits (e.g. apples) and two-and-a-half glasses of SSB per week, respectively. In the French national survey on nutrition and health[38], 80 % of the children and adolescents did not consume the recommended five servings of F&V daily and one-third consumed more than the PNNS recommendation of half a glass of SSB (125 ml) daily. The present study thus indicates that the gap between reality and the guidelines is even larger in children and adolescents from more disadvantaged backgrounds. These observations are worth considering for the development of future preventive actions involving diet, especially if they target lower-SEP population groups. In contrast with certain other studies[5,6,39], but in keeping with others[5,40], our findings did not confirm a positive social gradient for fish intake in children and adolescents. The type of fish consumed is, however, likely to vary according to SEP because of cost differences (for instance, fried or canned fish was shown to be consumed more often in disadvantaged populations than fresh fish, which is more expensive[4]). This could explain inconsistent results in the literature when fish is considered as a whole, with no distinction. Similarly, while we did not find a positive social gradient for dairy product intake as described in other studies[8,10,41], we found that the type of dairy products consumed was socially differentiated (positive links with SEP for yoghurt and cheese, negative links for milk). Other studies reported that children from a low SEP had higher intakes of high-fat dairy products[6,40,42] and lower intakes of low-fat dairy products[43]. As for fish, cost barriers could explain social differences in the type of dairy products consumed[44]. These SEP level-based differences are worth considering since food experiences during childhood influence the development of taste and food preferences,

Table 3 Mean food intakes (and standard deviations), in grams per day, according to five indicators of socio-economic position (SEP) in adolescents aged 11–17 years from the second French national food consumption survey (INCA2), 2006–2007*

	Occupational status†									Educational level‡						
	C1 (*n* 406)		C2 (*n* 192)		C3 (*n* 107)		C4 (*n* 174)			C1 (*n* 146)		C2 (*n* 480)		C3 (*n* 249)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*P*	Mean	SD	Mean	SD	Mean	SD	*P*
F&V	275·5	10·5	292·5	11·1	317·2	21·7	287·9	23·7	0·33	240·8	27·0	289·4	12·6	312·3	10·7	0·03
Vegetables	125·4	5·7	112·6	6·8	131·4	11·8	123·4	16	0·33	113·7	19·3	122·3	5·6	130·5	7·4	0·53
Fruit	150·1	9·0	180·0	9·7	185·8	17·0	164·6	17·3	0·04	127·1	11·9	167·1	11·5	181·8	7·5	<0·001
Starchy foods	219·9	5·5	204·2	6·0	189·5	5·4	222·1	11·8	<0·001	232·8	14·0	213·1	4·7	201·8	6·2	0·12
Bread	74·9	3·7	63·6	3·2	58·6	3·8	73·5	3·9	0·004	74·5	5·1	71·6	2·9	65·3	3·1	0·20
Pasta	50·0	2·5	45·5	2·9	38·8	2·6	53·7	6·4	0·01	59·0	8·1	48·3	2·1	42·7	2·8	0·12
Rice	23·8	2·1	30·4	3·5	27·5	2·9	27·5	3·4	0·29	30·5	4·6	22·7	1·7	30·8	2·9	0·009
Potatoes	61·6	2·6	58·2	2·7	52·5	3·4	57·5	6·4	0·13	55·2	6·7	62·5	2·2	54·0	2·4	0·04
Legumes	9·2	1·0	6·2	1·1	11·4	1·9	9·7	2·4	0·09	13·3	3·3	7·7	0·8	8·6	1·2	0·21
Meat/fish/eggs	130·3	3·1	118·7	4·3	127·5	4·7	124·3	6·8	0·27	122·9	6·6	128·6	2·6	123·6	4·4	0·60
Meat	102·2	2·8	86·7	3·0	93·2	5·5	92·6	7·2	0·007	94·6	6·4	98·1	2·4	91·6	3·3	0·35
Processed meat	31·4	1·7	21·5	1·6	23·8	2·1	27·0	2·4	<0·001	28·8	3·1	29·6	2·0	22·2	1·4	0·02
Fish	18·1	1·2	21·8	2·4	23·9	2·5	20·2	2·0	0·14	18·8	2·4	19·8	1·0	21·4	2·1	0·66
Eggs	10·0	0·8	10·1	1·1	10·4	1·5	11·4	1·3	0·82	9·5	1·6	10·7	0·7	10·6	0·8	0·80
Dairy products	246·4	8·5	241·2	12·6	271·1	19·3	249·5	18·9	0·68	228·6	23·2	249·5	7·4	260·3	10·8	0·43
Milk	171·9	7·8	152·5	13·2	191·5	18·8	166·7	17·0	0·43	171·0	23·0	169·5	7·2	165·7	9·7	0·95
Yoghurts	55·3	2·6	69·9	5·8	59·7	6·4	64·4	6·1	0·09	44·0	3·7	59·8	3·1	74·3	5·1	<0·001
Cheese	19·2	1·0	18·8	1·4	19·9	2·5	18·4	1·5	0·96	13·6	1·5	20·1	1·1	20·3	1·2	<0·001
SSB	126·2	8·3	107·3	10·0	94·3	15·9	127·5	20·2	0·19	163·5	26·8	128·7	8·4	71·4	6·9	<0·001
Other products																
Stewed fruit/fruit in syrup	11·6	1·3	11·2	1·6	12·2	1·7	8·0	2·3	0·54	7·6	1·8	12·0	1·4	10·6	1·3	0·18
Dairy desserts	28·8	1·8	27·9	3·9	19·9	2·6	29·5	4·6	0·03	28·0	6·3	30·9	1·9	21·7	2·5	0·04
Cakes/pastries	71·0	2·7	79·7	4·2	73·2	4·8	64·1	3·3	0·02	64·4	3·8	71·6	2·4	75·9	3·5	0·12
Confectionery	21·4	1·2	25·1	1·3	24·0	2·2	27·2	3·1	0·12	28·9	4·0	20·5	0·9	27·0	1·4	<0·001
Pizza/sandwiches	49·3	3·0	48·6	3·6	56·4	3·8	40·9	4·6	0·11	51·5	4·5	48·1	2·8	45·5	2·4	0·49

	Income per consumption unit§							Household wealth index§							Global SEP index§						
	T1 (*n* 286)		T2 (*n* 294)		T3 (*n* 301)			T1 (*n* 266)		T2 (*n* 283)		T3 (*n* 323)			T1 (*n* 262)		T2 (*n* 298)		T3 (*n* 287)		
	Mean	SD	Mean	SD	Mean	SD	*P*	Mean	SD	Mean	SD	Mean	SD	*P*	Mean	SD	Mean	SD	Mean	SD	*P*
F&V	277·7	15·8	277·5	12·7	304·9	10·8	0·16	265·4	19·7	280·7	15·2	310·8	10·2	0·05	267·5	18·4	283·8	11·7	311·2	11·3	0·07
Vegetables	127·9	10·7	120·0	7·7	120·9	7·6	0·84	115·0	7·7	128·2	12·1	124·4	6·8	0·59	120·2	11·3	130·0	8·1	118·1	6·2	0·52
Fruit	149·7	9·2	157·5	12·4	184·0	7·9	0·006	150·4	16·6	152·5	8·5	186·4	7·9	0·005	147·4	13·6	153·8	9·0	193·1	9·4	0·003
Starchy foods	217·3	8·2	220·2	5·8	203·8	6·1	0·18	225·4	9·8	213·0	4·3	204·9	5·9	0·21	225·9	9·3	208·5	5·1	204·8	5·8	0·15
Bread	66·1	3·0	79·2	4·3	65·8	2·7	0·02	71·4	4·3	68·6	3·2	71·1	2·9	0·77	72·6	4·4	70·1	3·1	67·1	2·8	0·58
Pasta	52·1	5·0	49·4	2·8	44·7	2·8	0·40	55·3	4·8	47·1	2·7	44·6	2·6	0·16	55·3	5·0	47·3	2·2	43·8	2·3	0·13
Rice	26·9	3·0	24·8	2·1	27·8	2·3	0·50	24·7	2·9	28·8	2·7	26·1	2·2	0·50	23·9	2·7	24·8	2·0	30·3	2·6	0·10
Potatoes	61·7	3·8	58·3	3·5	56·4	3·4	0·57	63·9	4·1	58·8	2·8	54·7	3·0	0·22	63·3	4·2	57·7	2·9	55·2	2·9	0·30
Legumes	10·2	1·9	8·0	1·0	8·8	1·1	0·52	9·8	2·1	9·4	1·2	8·1	0·9	0·54	10·7	2·0	8·3	1·2	8·0	0·9	0·45
Meat/fish/eggs	124·5	3·9	129·0	3·5	124·9	2·6	0·57	132·2	4·1	123·0	3·7	123·2	3·3	0·17	130·3	4·8	123·9	3·5	123·1	2·7	0·40
Meat	92·0	3·6	101·7	3·3	93·4	2·3	0·08	101·6	3·4	94·2	3·9	91·6	3·0	0·13	100·5	4·2	94·1	3·4	91·5	2·7	0·23
Processed meat	25·6	2·1	30·2	1·8	26·3	1·6	0·11	30·7	2·3	25·3	1·6	26·2	1·6	0·12	31·1	2·2	26·1	1·7	24·8	1·7	0·03
Fish	21·0	1·8	17·8	1·2	21·4	1·5	0·12	18·9	1·7	18·9	1·4	21·7	1·6	0·29	18·6	1·7	19·1	1·3	21·9	1·5	0·15
Eggs	11·5	1·3	9·6	0·9	10·1	0·9	0·56	11·6	1·2	10·0	0·8	9·9	0·8	0·52	11·3	1·2	10·7	0·9	9·7	0·9	0·55
Dairy products	259·7	15·6	228·8	11·9	257·5	9·2	0·14	246·2	13·3	240·2	14·8	257·6	10·8	0·60	240·4	13·8	250·3	9·9	251·3	10·8	0·79
Milk	185·7	14·4	155·2	11·9	165·4	8·1	0·28	174·0	13·7	163·4	12·2	167·7	9·7	0·85	172·3	13·4	169·5	8·8	159·5	9·5	0·66
Yoghurts	56·1	3·5	55·2	5·7	71·5	4·6	0·02	54·8	6·3	58·5	4·5	69·0	3·8	0·02	51·1	4·4	61·5	4·1	71·4	4·3	0·005
Cheese	17·9	1·3	18·4	1·3	20·6	1·3	0·03	17·4	1·4	18·3	1·2	20·8	1·0	0·08	17·0	1·3	19·3	1·4	20·4	1·1	0·15
SSB	122·9	14·4	131·4	11·9	103·1	7·6	0·10	151·7	16·7	106·5	9·6	103·9	10·3	0·04	142·5	15·6	123·3	11·4	95·3	8·3	0·02
Other products																					
Stewed fruit/fruit in syrup	7·4	0·8	10·6	1·5	14·1	1·8	0·001	9·3	1·7	9·9	1·4	12·5	1·4	0·26	9·8	1·5	9·3	1·3	13·2	1·6	0·16
Dairy desserts	29·6	3·7	29·5	2·5	24·3	2·1	0·24	29·6	3·9	27·1	2·4	27·1	3·0	0·86	30·4	4·0	28·1	2·2	25·0	3·5	0·68
Cakes/pastries	68·7	2·8	70·6	2·8	74·7	3·1	0·31	64·0	4·0	75·2	2·9	74·1	2·7	0·08	61·4	3·4	80·4	3·4	72·4	3·0	<0·001
Confectionery	24·1	2·3	24·2	1·6	23·2	1·2	0·83	22·7	1·9	24·0	2·1	24·6	1·6	0·71	24·5	2·6	22·4	1·5	25·1	1·4	0·39
Pizza/sandwiches	49·0	4·0	46·0	2·2	48·8	2·6	0·61	50·4	3·8	48·6	3·0	44·9	2·3	0·38	51·4	3·7	45·8	3·3	47·4	2·6	0·52

F&V, fruit and vegetables; SSB, sugar-sweetened beverages.

*Mean intake (SD) adjusted for age, gender and energy intake·

†Categories for occupational status: C1, low; C2, intermediate; C3, high; C4, inactive.

‡Categories for educational level: C1, low; C2, intermediate; C3, high.

§Tertiles for the household wealth index, the global SEP index and the income per consumption unit: T1, <€725/month; T2, €725–1330/month, T3, ≥€1330/month.

Table 4 Mean energy and macronutrient intakes (and standard deviations) according to according to five indicators of socio-economic position (SEP) in children aged 3–10 years from the second French national food consumption survey (INCA2), 2006–2007*

	Occupational status†								
	C1 (*n* 253)		C2 (*n* 135)		C3 (*n* 48)		C4 (*n* 110)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*P*
Total energy intake (kJ/d)	6933	95	7089	127	6847	207	6986	131	0·77
Total energy intake (kcal/d)	1657·1	22·7	1694·4	30·3	1636·4	49·4	1669·7	31·2	0·77
Protein intake (g/d)	63·1	0·5	63·3	0·9	63·0	1·3	61·5	1·0	0·44
Carbohydrate intake (g/d)	187·6	1·2	186·6	2·1	190·2	2·0	187·5	1·8	0·51
Sugar	97·8	1·0	97·3	1·6	103·2	1·8	97·8	2·3	0·03
Starch	89·8	1·3	89·3	1·1	87·0	1·6	89·7	1·7	0·50
Lipid intake (g/d)	70·9	0·5	71·6	0·8	70·2	1·0	71·6	0·7	0·46
PUFA	9·7	0·2	9·5	0·2	8·9	0·4	9·7	0·2	0·33
MUFA	24·8	0·2	25·4	0·4	24·9	0·7	25·3	0·4	0·39
SFA	30·8	0·3	31·1	0·4	31·1	0·5	31·1	0·5	0·85

	Educational level‡						
	C1 (*n* 70)		C2 (*n* 298)		C3 (*n* 204)		
	Mean	SD	Mean	SD	Mean	SD	*P*
Total energy intake (kJ/d)	6807	199	6996	87	6990	87	0·65
Total energy intake (kcal/d)	1626·9	47·5	1672·2	20·7	1670·7	20·7	0·65
Protein intake (g/d)	64·7	1·6	63·0	0·5	62·1	0·6	0·25
Carbohydrate intake (g/d)	186·7	2·9	187·2	1·1	188·3	1·4	0·78
Sugar	91·9	2·3	97·8	1·4	100·3	1·1	0·002
Starch	94·7	2·0	89·4	1·1	88·1	1·1	0·03
Lipid intake (g/d)	70·3	1·5	71·2	0·5	71·3	0·5	0·81
PUFA	9·9	0·3	9·6	0·2	9·5	0·2	0·61
MUFA	24·4	0·8	24·9	0·3	25·4	0·2	0·25
SFA	30·3	0·7	31·1	0·3	30·9	0·3	0·47

	Income per consumption unit§						
	T1 (*n* 181)		T2 (*n* 171)		T3 (*n* 194)		
	Mean	SD	Mean	SD	Mean	SD	*P*
Total energy intake (kJ/d)	6921	120	6958	104	7036	87	0·71
Total energy intake (kcal/d)	1654·2	28·8	1663·1	24·8	1681·7	20·9	0·71
Protein intake (g/d)	63·2	0·8	62·4	0·6	62·7	0·6	0·75
Carbohydrate intake (g/d)	186·3	1·6	188·5	1·4	188·0	1·3	0·56
Sugar	94·5	1·5	98·9	1·6	100·9	0·9	<0·001
Starch	91·8	1·2	89·5	1·5	87·1	1·1	0·02
Lipid intake (g/d)	71·4	0·7	70·9	0·6	71·1	0·5	0·89
PUFA	9·9	0·3	9·8	0·3	9·2	0·2	0·05
MUFA	25·1	0·3	24·7	0·3	25·3	0·3	0·25
SFA	30·6	0·4	30·9	0·3	31·3	0·3	0·35

	Household wealth index§							Global SEP index§						
	T1 (*n* 194)		T2 (*n* 197)		T3 (*n* 153)			T1 (*n* 190)		T2 (*n* 163)		T3 (*n* 175)		
	Mean	SD	Mean	SD	Mean	SD	*P*	Mean	SD	Mean	SD	Mean	SD	*P*
Total energy intake (kJ/d)	6924	111	6859	83	7200	116	0·04	6912	116	6912	104	7115	94	0·18
Total energy intake (kcal/d)	1654·8	26·6	1639·4	19·9	1720·8	27·8	0·04	1652·0	27·7	1651·9	24·9	1700·6	22·5	0·18
Protein intake (g/d)	63·9	0·6	61·3	0·6	63·2	0·8	0·003	63·4	0·7	63·1	0·6	61·9	0·7	0·22
Carbohydrate intake (g/d)	185·7	1·4	190·3	1·7	186·5	1·7	0·07	186·6	1·3	187·8	1·8	188·9	1·5	0·50
Sugar	95·6	1·4	100·1	1·5	98·9	1·2	0·04	95·9	1·4	97·8	1·6	101·1	1·0	0·007
Starch	90·1	1·1	90·2	1·3	87·6	1·4	0·25	90·7	1·2	90·0	1·5	87·8	1·3	0·25
Lipid intake (g/d)	71·2	0·6	70·8	0·8	71·6	0·6	0·77	71·2	0·6	71·3	0·8	71·3	0·5	0·97
PUFA	9·7	0·3	9·6	0·2	9·3	0·2	0·40	9·7	0·3	9·7	0·2	9·3	0·2	0·24
MUFA	25·0	0·3	24·8	0·4	25·4	0·3	0·62	25·0	0·3	24·8	0·4	25·4	0·3	0·45
SFA	30·7	0·4	30·7	0·4	31·5	0·4	0·45	30·6	0·4	31·3	0·3	31·1	0·3	0·36

*Mean intake (SD) adjusted for age, gender and energy intake (except for energy intake)·

†Categories for occupational status: C1, low; C2, intermediate; C3, high; C4, inactive.

‡Categories for educational level: C1, low; C2, intermediate; C3, high.

§Tertiles for the household wealth index, the global SEP index and the income per consumption unit: T1, <€725/month; T2, €725–1330/month, T3, ≥€1330/month.

Table 5 Mean energy and macronutrient intakes (and standard deviations) according to five indicators of socio-economic position (SEP) in adolescents aged 11–17 years from the second French national food consumption survey (INCA2), 2006–2007*

	Occupational status†								
	C1 (*n* 388)		C2 (*n* 185)		C3 (*n* 101)		C4 (*n* 161)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*P*
Total energy intake (kJ/d)	7992	118	8097	152	8094	192	8437	190	0·03
Total energy intake (kcal/d)	1862·4	28·2	1935·2	36·3	1934·5	46·0	2016·5	45·5	0·03
Protein intake (g/d)	74·6	0·6	72·5	0·8	75·1	1·1	71·6	1·6	0·16
Carbohydrate intake (g/d)	216·9	1·6	216·2	1·8	210·1	2·0	221·9	2·8	0·004
Sugar	96·4	1·5	100·1	1·9	98·9	1·9	101·2	2·1	0·34
Starch	120·5	1·6	116·1	1·5	111·2	1·5	120·7	2·7	<0·001
Lipid intake (g/d)	78·0	0·7	79·8	0·7	80·9	0·9	77·0	1·2	0·03
PUFA	10·6	0·2	10·5	0·2	10·6	0·3	10·9	0·5	0·92
MUFA	27·4	0·3	28·6	0·4	29·4	0·5	27·1	0·5	0·003
SFA	32·9	0·3	33·8	0·3	34·0	0·5	32·1	0·7	0·04

	Educational level‡						
	C1 (*n* 135)		C2 (*n* 459)		C3 (*n* 238)		
	Mean	SD	Mean	SD	Mean	SD	*P*
Total energy intake (kJ/d)	7869	283	8012	128	8215	132	0·39
Total energy intake (kcal/d)	1880·8	67·7	1914·8	30·6	1963·4	31·5	0·39
Protein intake (g/d)	71·0	1·6	74·2	0·5	73·7	0·6	0·17
Carbohydrate intake (g/d)	226·2	3·6	215·8	1·5	213·4	1·6	0·004
Sugar	100·5	2·8	98·2	1·4	97·8	1·8	0·67
Starch	125·7	3·5	117·6	1·2	115·6	1·4	0·03
Lipid intake (g/d)	74·4	1·6	78·8	0·6	80·4	0·6	0·003
PUFA	10·9	0·6	10·5	0·2	10·7	0·2	0·65
MUFA	25·8	0·6	27·8	0·3	29·2	0·3	<0·001
SFA	30·6	0·8	33·5	0·4	33·8	0·3	0·001

	Income per consumption unit§						
	T1 (*n* 272)		T2 (*n* 272)		T3 (*n* 292)		
	Mean	SD	Mean	SD	Mean	SD	*P*
Total energy intake (kJ/d)	7933	163	8078	156	8116	130	0·64
Total energy intake (kcal/d)	1896·0	38·9	1930·8	37·2	1939·7	31·0	0·64
Protein intake (g/d)	73·1	1·0	73·5	0·6	73·9	0·5	0·70
Carbohydrate intake (g/d)	218·9	2·2	217·5	1·7	214·6	1·5	0·21
Sugar	98·7	1·8	96·9	1·7	99·9	1·3	0·42
Starch	120·2	2·3	120·6	1·5	114·8	1·3	0·01
Lipid intake (g/d)	77·4	1·0	78·1	0·8	79·6	0·6	0·10
PUFA	10·9	0·3	10·9	0·3	10·3	0·2	0·16
MUFA	27·1	0·4	27·5	0·4	28·7	0·3	0·003
SFA	32·3	0·6	32·7	0·4	33·9	0·3	0·007

	Household wealth index§							Global SEP index§						
	T1 (*n* 251)		T2 (*n* 266)		T3 (*n* 312)			T1 (*n* 247)		T2 (*n* 283)		T3 (*n* 277)		
	Mean	SD	Mean	SD	Mean	SD	*P*	Mean	SD	Mean	SD	Mean	SD	*P*
Total energy intake (kJ/d)	8042	205	7912	122	8168	131	0·36	8076	178	7838	130	8233	132	0·12
Total energy intake (kcal/d)	1922·1	49·1	1891·0	29·1	1952·2	31·2	0·36	1930·2	42·6	1873·4	31·1	1967·8	31·6	0·12
Protein intake (g/d)	74·1	1·0	73·1	1·0	73·1	0·6	0·70	73·3	1·2	73·4	0·7	73·3	0·6	0·99
Carbohydrate intake (g/d)	219·5	2·1	215·9	1·9	216·1	1·7	0·41	220·2	2·1	216·3	2·0	214·9	1·5	0·13
Sugar	99·0	1·9	95·9	1·4	100·7	1·5	0·04	98·4	1·8	98·5	1·7	99·7	1·5	0·84
Starch	120·5	2·1	120·1	2·0	115·4	1·3	0·04	121·8	2·4	117·9	1·6	115·2	1·3	0·05
Lipid intake (g/d)	76·4	1·1	79·2	0·7	79·3	0·6	0·08	76·3	1·0	78·9	0·8	79·9	0·6	0·02
PUFA	10·8	0·4	10·8	0·3	10·4	0·2	0·28	11·0	0·4	10·3	0·2	10·6	0·2	0·27
MUFA	26·9	0·4	28·1	0·4	28·2	0·3	0·03	26·7	0·4	27·8	0·4	28·9	0·4	<0·001
SFA	31·5	0·5	33·3	0·5	33·9	0·3	<0·001	31·5	0·5	33·8	0·4	33·7	0·3	<0·001

*Mean intake (SD) adjusted for age, gender and energy intake (except for energy intake)·

†Categories for occupational status: C1, low; C2, intermediate; C3, high; C4, inactive.

‡Categories for educational level: C1, low; C2, intermediate; C3, high.

§Tertiles for the household wealth index, the global SEP index and the income per consumption unit: T1, <€725/month; T2, €725–1330/month, T3, ≥€1330/month.

which in turn affect subsequent eating habits[45]. Furthermore, there is some evidence that dietary intakes from childhood carry on into adolescence and even adulthood[46,47]. While social differences in intakes may appear rather small when food groups are considered separately, their accumulation across food groups is worth considering and may have an impact on the opportunity to fulfil nutritional requirements with regard to vitamins and minerals (data not shown). These differences over the life course are also worth considering. Indeed, the early establishment of suboptimal and socially differentiated dietary intakes, even low, which are maintained once habits are formed, is thought to lead to a cumulative increase in positive energy balance over the life course, favouring the development of body fat among the most disadvantaged groups and contributing to social inequalities in health.

With regard to macronutrients, there was no evidence of a SEP gradient for protein intake as described in other studies[6,10,48]. This is coherent with the absence of major social differences for protein-rich foods when addressed as a whole (i.e. meat/fish/egg and dairy products). Findings are, however, inconsistent in the literature, which suggests a SEP-driven substitution of animal products within a given food group (fat meat *v.* lean meat, processed meat *v.* meat, milk *v.* yoghurt, canned fish *v.* fresh fish, etc.), resulting in a similar protein intake across SEP groups[4,8]. In children, carbohydrate intake was not associated with SEP, whereas adolescents from lower SEP had a higher carbohydrate intake. While Cribb *et al.* observed similar results in their study[6], findings are not consistent in the literature[4,10]. This could be partially explained by the distinction made or not made between starch and sugars. We found that children from lower SEP had a higher starch intake and a lower sugar intake (despite higher intake of SSB), which is coherent with their higher consumption of starchy foods (in particular pasta and pizza/sandwiches) and their lower consumption of fruit-based products, yoghurts (lactose) and confectionery. Despite the absence of a relationship between sugar intake and SEP in adolescents, we can however assume that naturally occurring and added sugars are likely to be socially differentiated since adolescents from lower SEP had a lower intake of both fruit and foods containing lactose (e.g. yoghurts and cheese) but a higher intake of SSB. Total lipid intake was not significantly associated with SEP in children, whereas a positive association was found in adolescents (especially for SFA and MUFA). It should be noted that the literature has tended to report an inverse association[6,8,10,48]. These findings are nevertheless coherent with the observed associations in children between SEP and foods that substantially contribute to lipid intake: SEP was inversely associated with pizzas/sandwiches, meat and processed meat, but positively associated with yoghurts. The interpretation of the findings for adolescents is less straightforward, as SEP was inversely associated with dairy desserts, meat and processed meat but positively associated with yoghurts, cheese and cakes/pastries. Finally, we did not find any evidence of a social gradient in energy intake as described in certain studies[6,8], but in keeping with others[4,9,10]. While this could be due to differential under-reporting bias based on SEP[49], these findings shed light on social differences in terms of diet quality persisting from childhood to adolescence, with nutrient-dense foods less represented in the diet of children and adolescents from more disadvantaged backgrounds, conversely to energy-dense foods and SSB. Such a diet is supposed to partially mediate the negative association between SEP and overweight in children, as suggested from previous findings based on the INCA1 data set[13]. In addition, a recent review showed that SSB consumption was positively associated with BMI in children, which could be explained by a high added-sugar content and low satiety effect of liquids[50]. These results suggest the need to continue and even step up policies to reduce added-sugar intake, particularly from SSB, and promote the consumption of more nutrient-dense foods.

We found that while the associations observed for a given food group were globally robust across the various SEP indicators, the social gradient for dietary intake was steeper for the 'caregiver's educational level' indicator. Zarnowiecki *et al.* have also shown that the mother's education appeared to be more frequently associated with children's dietary intake than other SEP indicators[22]. The strong association found with the caregiver's educational level could come from a poorer understanding and appropriation of general nutritional messages, as well as poorer knowledge of the best parental practices which impact food choices for children[51–55]. Adults with a higher education are more health-conscious and thus likely to adopt healthier dietary habits for their children, for example by increasing the availability of healthy foods at home[35,41,51,56]. It should be noted that when income and educational level were both included in the same model, relationships with educational level remained significant, whereas relationships with income did not (data not shown). The parents' occupational status, income and household wealth are more susceptible to change over time than educational level, which may also explain the stronger relationship observed between diet and educational level. Besides, in the population studied, income would appear less discriminant than educational level with regard to food choices. Given that the associations under examination were generally stronger with regard to education than with regard to occupation, income or household wealth, it was not surprising to find weaker associations with the global SEP index, the latter being based mainly on income and household wealth characteristics.

Strengths and limitations

Although there is no consensus on the best indicator for measuring SEP in the context of nutritional epidemiology, one strength of our study was to have addressed the multidimensionality of the association between SEP and diet while accounting for comprehensive SEP indicators. We also derived composite indices (household wealth and overall SES), which is a complementary approach rarely undertaken before[20]. Our results confirmed a social gradient for a wide range of socio-economic factors, providing robustness and original insights into the issue of social inequalities in diet during childhood, based on the most recent representative data available in France using gold standard measures for diet. However, even if we could investigate the relative associations between different aspects of SEP and both dietary and nutrient intakes at the national level, the measurements of social status addressed here do not encompass all aspects of SEP (for instance, the parents' cultural origin and area deprivation were not included in the analysis because they were not available in the study). We also acknowledge that household income was imputed to a substantial proportion of the sample (20 %). Sensitivity analyses were therefore conducted excluding participants with missing data for income (data not shown). Despite a trend towards higher *P* values (probably due to a lower sample size), findings were generally consistent in terms of effect size.

We are aware that a potential bias towards under-reporting of food intake, a weakness inherent to all methods used to assess food intake, cannot be ruled out. This might have affected the estimation of dietary and nutritional intakes, especially in adolescents[49]. While this could possibly explain why fewer SEP differences were identified in adolescents, we cannot exclude that adolescents from all socio-economic groups simply have poorer diets than their younger counterparts. Several reasons led us to include the probable under-reporters in the analyses. It has been argued that low reporting of energy may concern not only those identified as under-reporters, but also those with plausible energy intakes[57]. Therefore, selectively excluding those with implausible energy intakes could also bias the results. It is also likely that a significant proportion of the children identified as under-reporters are true under-eaters, in cases of weight-loss dieting. This issue is particularly sensitive during adolescence. In the context of a study aiming to describe overall diet on the national level, it makes sense to include individuals who are on restrictive diets.

Finally, the relationships found in the current study are consistent with those observed in adults[4]. However, our study in the general population did not include the most disadvantaged people. In France, the ABENA study (2004–2005) focused on food-aid beneficiaries and showed that these adults had an unhealthy diet characterised by low intakes of F&V, dairy products and foods from the meat/fish/egg group and ran a high risk of nutritional deficiencies[58,59]. There are few data on children's intake but, depending on the study area, between 25 and 78 % of food-aid beneficiaries had at least one child to care for. A recent article indicated a high prevalence of anaemia and overweight in the children of French homeless families[60]. Given that nutrient-dense foods are more expensive than energy-dense foods[61–63], we cannot exclude that, in more disadvantaged population groups, income plays a more important role than educational level with regard to the introduction of non-core foods to the children's diet. Remarkably, the current findings confirm social gradients in the types of food consumed even in this fairly low-risk sample, thus strengthening public health arguments.

Conclusion

By using several SEP indicators, the present study allowed us to explore the multidimensionality of the association between SEP and diet. Social inequalities across SEP indicators were more clearly expressed in terms of food choices than in terms of energy or macronutrient intakes. The gap with regard to national guidelines, wider in lower SEP, suggests the need to focus prevention on specific food groups, especially SSB and F&V. Moreover, the strong associations observed in our study with the caregiver's educational level confirm that this indicator plays a major role in making healthy dietary choices. Our findings thus support the need to tailor messages for families with a low educational level to help them make healthier choices, pass on healthy eating habits to their children, give them the opportunity of meeting recommendations, and ultimately to give them the keys to better health.

Acknowledgements

Acknowledgements: The authors would like to thank the ISL team (Institut de Sondage Lavialle) for collecting data, and all the families involved for their cooperation. *Financial support:* This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors. The INCA2 survey was supported by a grant from the French Food Safety Agency (AFSSA). *Conflict of interest:* None. *Authorship:* P.D.-P. designed the study, analysed data and wrote the paper. C.D., S.L. and J.-L.V. contributed to INCA2 survey data collection. All the co-authors participated in study design and reviewed the manuscript. S.L. and J.-L.V. contributed equally and are co-last authors. *Ethics of human subject participation:* The INCA2 survey was approved by the French Data Protection Authority (CNIL).

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