Prevalence and factors associated with overweight and obesity in French primary-school children

Hélène Thibault[1,2,*], Caroline Carriere[1,2], Coralie Langevin[1,2], Edouard Kossi Déti[1], Pascale Barberger-Gateau[2] and Sylvie Maurice[1]

[1]Univ. Bordeaux, ISPED, Centre INSERM U897-Epidemiologie-Biostatistique, F-33000 Bordeaux, France:
[2]INSERM, ISPED, Centre INSERM U897-Epidemiologie-Biostatistique, Bordeaux, France

Abstract

Objective: To determine the prevalence of, and identify associated factors with, overweight and obesity in two samples of French children.
Design: We conducted two cross-sectional studies among two samples of children. Weight status, eating behaviour, sedentary activity, physical activity and parents' socio-economic status (SES) were collected using questionnaires filled by doctors during school health check-ups. Overweight and obesity were defined according to the age- and sex-specific BMI cut-off points of the International Obesity Task-force. Multivariate analysis (logistic regression) was used to identify independent factors associated with overweight including obesity and obesity alone.
Setting: Aquitaine region (south-west France).
Subjects: Analyses were conducted among children aged 5–7 years (n 4048) and 7–11 years (n 3619).
Results: Overweight prevalence was 9·5% including 2·2% of obesity in 5–7-year-old children and 15·6% including 2·9% of obesity in 7–11-year-old children. In both samples, overweight and obesity prevalence were higher in children whose parents had low or medium SES ($P < 0.05$). Factors associated significantly ($P < 0.05$) and independently with higher overweight or obesity prevalence were female gender, low or medium parental SES, never or sometimes having breakfast, never eating at the school canteen, never having a morning snack, never or sometimes having a light afternoon meal and having high sedentary activity.
Conclusions: Our data confirm that low SES, absence of breakfast and high sedentary activity are associated with a higher risk of being overweight or obese, but also highlight original potential protective factors such as eating at the canteen and high meal frequency.

Since 1998, the WHO has recognized obesity as a major public health epidemic[1]. Indeed, overweight and obesity are established risk factors for several chronic diseases[2–4] and their prevalence in children has increased dramatically over the past few years worldwide, especially in the developed countries[5–7]. Several factors have been found to be associated with a higher risk of paediatric overweight and/or obesity, such as demographic, economic and social factors[8,9], but also individual behaviours such as eating behaviour and physical or sedentary activity[10,11]. In France, the National Nutrition and Health Program[12] was launched in 2001 by the Ministry of Health. One of its main objectives is to stop the increase in childhood obesity[12,13]. Thus, several studies on representative samples of French children have shown that, after increasing since the 1990s, overweight prevalence (including obesity) nationwide seems to have stabilized at about 16% since the 2000s[14–17].

Locally, various public health actions have been implemented such as in Aquitaine (south-west France) since November 2004 thanks to the programme 'Nutrition, Prevention and health of children and teenagers in Aquitaine' (www.nutritionenfantaquitaine.fr). Its objectives are to improve the dietary behaviour of children and teenagers by promoting healthy food consumption (particularly fruit and vegetables) and physical activity, thereby contributing to stabilizing childhood overweight prevalence[18]. Before and after implementing these interventions, surveys were conducted to provide guidelines and baseline data in order to evaluate the programme's impact on children (diet, level of physical activity, overweight prevalence). The objective of the present study was to identify social, economic and lifestyle factors associated with overweight or obesity in primary-school children (5–11 years old) using two surveys conducted among 5–7- and 7–11-year-old children in Aquitaine from 2007 to 2009.

Corresponding author: Email HeleneThibault@aol.com

Methods

Design and participants

Two cross-sectional surveys were conducted in representative samples obtained by a cluster sampling procedure in Aquitaine. Clusters were primary schools.

Schools were randomly selected by taking into account districts (five in Aquitaine), school zone category (low socio-economic (LSE) area or non-LSE area) and geographical area (urban or rural) as well as school size. The database of schools' characteristics used for this sampling procedure was provided by the regional education authority. About 20 % of primary schools of the five districts of the region were selected, and they all agreed to participate. The schools selected for each survey could be different.

Two samples of children were studied:

1. '5–7-year-old sample', examined from September 2007 to June 2008, among 5–7-year-old children ($n_{schools}$ 194);
2. '7–11-year-old sample', examined from September 2008 to June 2009, among 7–11-year-old children ($n_{schools}$ 192).

All children aged 5–7 years or 7–11 years from the selected schools seen by school doctors or nurses during the systematic school health check-up were included in the surveys. Prior consent for participation was obtained from the children's parents. Data transmitted for the analysis were anonymous.

Measurements

In France, a medical school service, including nurses and medical doctors, is responsible for monitoring the health of children when they attend school. Every school year, a systematic medical health examination is performed once for all 5–7-year-old schoolchildren by school doctors and for all 7–11-year-old schoolchildren by school doctors and nurses. During this systematic examination, school doctors or nurses screen health or behaviour problems, but also check the weight status of each child.

The weight status of children was defined from anthropometric data (weight and height) collected by school doctors or nurses. Weight and height were measured in the morning or the afternoon (fasting is not necessary), using a standardized procedure and devices for measurement, at each school health centre. Weight was measured in lightly dressed children, without shoes, with school health centre scales. Height was measured using a stadiometer with the child standing up with his/her weight being equally distributed on the two feet, head back and buttock on the vertical part of the height gauge.

Other data concerning information about sex, age, eating behaviour, sedentary and physical activity and parents' socio-economic status (SES) were collected by questionnaires (validated by partners of the Aquitaine programme) completed by parents for the 5–7-year-old sample and by the school nurses for the 7–11-year-old sample.

Variables

Weight status

BMI (kg/m^2) was calculated as [weight (kg)]/[height (m)]^2. Weight status (normal, overweight or obesity) was classified using the cut-offs of the International Obesity Taskforce[19].

Eating behaviour

Collected information concerned breakfast intake eating habits at the school canteen (only available for 5–7-year-old children), light afternoon meal intake, nibbling (never, sometimes or always for each item) and morning snack intake (yes/no).

Sedentary activity

Sedentary activity was estimated by weekly 'screen viewing time'. This time was obtained by adding up time spent watching television, using a computer and playing video games per week. For the 5–7-year-old and the 7–11-year-old samples, the mean of weekly 'screen viewing time' was estimated. Then sedentary activity level was divided into two classes using the mean of each sample: sedentary activity level was considered as 'high' when the screen viewing time was higher than the mean and as 'low' when lower.

Physical activity in leisure centres and sport clubs

Collected information concerned participation in leisure centres (never, some Wednesdays or every Wednesday, i.e. day without school) and in sport clubs (yes/no).

Parents' socio-economic status

SES of the father and mother was assessed according to their professional occupation. Three work categories, used by the French Ministry of Education, were defined according to the definition of the National Institute for Statistics and Economic Studies[20]: 'high' (managers, executives, independent professionals); 'medium' (craftsmen, tradesmen, shopkeepers, proprietary business owners, office workers, employees, farmers, land-holders); and 'low' (manual workers, retired, unemployed, etc.). The SES of the household was assessed by combining both parents' status: 'high' if at least one of the parents had a high status; 'medium' if at least one had a medium status and neither had a high status; and 'low' if both parents had a low status.

Low socio-economic area schools (state-run schools only)

In France, state-run schools are classified by the school administration as LSE (low SES) schools or non-LSE (non-low SES) schools, according to the socio-economic characteristics of the area where they are located[21,22].

Other variables

The National Institute for Statistics and Economic Studies classifies geographical areas as urban when continuously

comprising 2000 persons or more. All other areas are classified as rural.

Statistical analysis

Data entry was performed using the EpiData software and analysis using the SAS statistical software package version 9·1·3. Differences between samples were assessed by the χ^2 test or the Kruskal–Wallis test. A P value <0.05 was considered statistically significant.

Univariate analyses examined the association of data of interest (eating behaviour, sedentary and physical activity, parental SES) with overweight (obesity included) or obesity alone as respective dependent variable, using the χ^2 test to determine statistical significance. Variables found to be significant at the univariate stage at $P < 0.20$ were then entered into a logistic regression analysis (multivariate analysis) using the same dependent variables.

Sampling design was taken into account during statistical analysis using a generalized estimating equation (GEE) model (GENMOD procedure). The Hosmer–Lemeshow goodness-of-fit test was used to assess the ability of the logistic regression model to predict the response variable.

Results

Study population

For the 5–7-year-old sample, 4048 children were included and 3619 for the 7–11-year-old sample. The male:female ratio was respectively 1·05 and 1·01.

Demographic characteristics, SES, eating habits, sedentary and physical activity of both 5–7-year-old and 7–11-year-old samples are described in Table 1. The mean time of sedentary activity was 9·1 h weekly for the 5–7-year-old sample and 2·8 h weekly for the 7–11-year-old sample.

Table 1 Weight status and characteristics of children: cross-sectional surveys in primary schools in the Aquitaine region, France, 2007–2009

Variable	5–7-year-old sample		7–11-year-old sample	
	n	%	n	%
Child's weight status	4048		3619	
Normal weight	3665	90·5	3054	84·4
Overweight	293	7·3	460	12·7
Obesity	90	2·2	105	2·9
Gender	4048		3619	
Male	2080	51·4	1815	50·2
Female	1968	48·6	1804	49·8
Geographical area	4048		3619	
Urban	2932	72·4	2360	65·2
Rural	1116	27·6	1259	34·8
Zone	4048		3619	
Non-LSE	3614	89·3	3365	93·0
LSE	434	10·7	254	7·0
Parent's SES	3964		3532	
High	1715	43·3	1443	40·9
Medium	1441	36·3	1488	42·1
Low	808	20·4	601	17·0
Eating at the canteen	3837			
Never	475	12·4	Not available	
Sometimes	906	23·6		
Always	2456	64·0		
Breakfast	3881		3619	
Always	3634	93·6	3510	97·0
Never or sometimes	247	6·4	107	3·0
Morning snack	3850		3596	
No	2349	61·0	2569	71·4
Yes	1501	39·0	1027	28·6
Light afternoon meal	3864		3584	
Always	3446	89·2	3313	92·4
Never or sometimes	418	10·8	271	7·6
Nibbling	3599		3540	
Never or sometimes	3210	89·2	2970	83·9
Often or always	389	10·8	570	16·1
Sedentary activity	3403		3243	
Low	1852	54·4	1879	57·9
High	1551	45·6	1364	42·1
Leisure club	3825		3515	
Every Wednesday	383	10·0	271	7·7
Never or some Wednesdays	3442	90·0	3244	92·3
Sports club	3834		3614	
Yes	1859	48·5	2585	71·5
No	1975	51·5	1029	28·5

LSE, low socio-economic; SES, socio-economic status.

Prevalence of overweight and obesity

For the 5–7-year-old sample, overweight (including obesity) and obesity prevalences were respectively 9·5 % and 2·2 %. For the 7–11-year-old sample, overweight (including obesity) and obesity prevalences were respectively 15·6 % and 2·9 % (Table 1).

Factors associated with overweight (including obesity)

Univariate analysis

For children from the 5–7-year-old sample, factors significantly associated ($P < 0·05$) with higher risk of overweight (including obesity) were: female gender, low or medium SES of the household, absence or rare intake of breakfast or light afternoon meal and having a high level of sedentary activity (Table 2).

For children from the 7–11-year-old sample, factors significantly associated ($P < 0·05$) with higher risk of overweight (including obesity) were: female gender, low or medium SES of the household, absence of a morning snack and having a high level of sedentary activity (Table 2).

Multivariate analysis

In addition to variables significantly associated with overweight (including obesity) in the univariate analysis ($P < 0·05$), variables with $P < 0·20$ were included in the multivariate final model: LSE status and eating at the canteen for the 5–7-year-old sample; LSE status and geographical area for the 7–11-year-old sample. Only significant variables were presented in Table 3.

Among children from the 5–7-year-old sample, variables significantly associated with a higher prevalence of overweight (including obesity) in the multivariate analysis were: female gender, low or medium SES of the household, absence or rare breakfast intake, absence or rare light afternoon meal intake and having a high sedentary

Table 2 Factors associated with overweight (including obesity) in children aged 5–7 years (*n* 4048) and 7–11 years (*n* 3619): cross-sectional survey in primary schools in the Aquitaine region, France, 2007–2009

Variable	5–7-year-old sample			7–11-year-old sample		
	OR	95 % CI	*P*	OR	95 % CI	*P*
Gender						
Male (ref.)						
Female	1·6	1·3, 2·0	$<10^{-4}$	1·3	1·1, 1·5	0·01
Geographical area						
Urban (ref.)						
Rural	1·1	0·8, 1·4	0·50	1·2	0·9, 1·4	0·15
Zone						
Non-LSE (ref.)						
LSE	1·3	1·0, 1·8	0·08	1·4	1·0, 2·1	0·07
Parent's SES						
High (ref.)						
Medium	1·5	1·1, 1·9	$<10^{-4}$	1·8	1·4, 2·2	$<10^{-4}$
Low	2·2	1·6, 2·9		2·0	1·5, 2·6	
Eating at the canteen						
Never (ref.)				Not available		
Sometimes	0·8	0·6, 1·0	0·09			
Always	0·7	0·5, 1·0				
Breakfast						
Always (ref.)						
Never or sometimes	2·1	1·5, 3·0	$<10^{-4}$	1·2	0·7, 2·0	0·39
Morning snack						
No (ref.)						
Yes	1·1	0·8, 1·4	0·79	0·8	0·6, 0·9	0·01
Light afternoon meal						
Always (ref.)						
Never or sometimes	1·4	1·0, 1·8	0·03	1·0	0·7, 1·5	0·90
Nibbling						
Never or sometimes (ref.)						
Often or always	1·0	0·7, 1·5	0·84	1·0	0·8, 1·3	0·95
Sedentary activity						
Low (ref.)						
High	1·5	1·2, 1·9	6×10^{-4}	1·3	1·1, 1·6	0·01
Leisure club						
Every Wednesday (ref.)						
Never or some Wednesdays	1·2	0·8, 1·6	0·37	1·2	0·9, 1·7	0·30
Sports club						
Yes (ref.)						
No	1·0	0·9, 1·3	0·57	1·0	0·8, 1·2	0·89

Univariate logistic regression analysis.
ref., referent category; LSE, low socio-economic; SES, socio-economic status.

Table 3 Factors associated with overweight (including obesity) in children aged 5–7 years (*n* 3834) and 7–11 years (*n* 3448): cross-sectional survey in primary schools in the Aquitaine region, France, 2007–2009

Variables	5–7-year-old sample			7–11-year-old sample		
	OR	95 % CI	*P*	OR	95 % CI	*P*
Gender						
Male (ref.)						
Female	1·6	1·2, 2·0	3×10^{-4}	1·4	1·2, 1·7	6×10^{-4}
Parents' SES						
High (ref.)						
Medium	1·4	1·1, 1·8	$<10^{-3}$	1·8	1·4, 2·2	$<10^{-4}$
Low	1·9	1·4, 2·8		2·0	1·6, 2·6	
Breakfast						
Always (ref.)						
Never or sometimes	1·9	1·3, 2·7	$<10^{-4}$		Not in final model	
Morning snack						
No (ref.)						
Yes		Not in final model		0·8	0·6, 1·0	0·02
Light afternoon meal						
Yes (ref.)						
Never or sometimes	1·3	1·1, 1·8	0·04		Not in final model	
Sedentary activity						
Low (ref.)						
High	1·3	1·1, 1·7	10^{-3}	1·2	1·0, 1·5	0·04

Multivariate logistic regression analysis (final model).
ref., referent category; SES, socio-economic status.

activity (all *P* < 0·05; Table 3). The model was adequate for predicting overweight (including obesity) in the target population: $\chi^2_{(5df)} = 3 \cdot 7$; *P* = 0·59 (Hosmer–Lemeshow goodness-of-fit test).

Among children from the 7–11-year-old sample, variables independently associated with a higher prevalence of overweight (including obesity) were: female gender, a low or medium SES of parents, absence of morning snack intake and having a high sedentary activity (all *P* < 0·05; Table 3). The model was adequate for predicting overweight (including obesity) in the target population: $\chi^2_{(7df)} = 3 \cdot 3$; *P* = 0·86 (Hosmer–Lemeshow goodness-of-fit test).

Factors associated with obesity

Univariate analysis

For the 5–7-year-old sample, variables significantly associated (*P* < 0·05) with a higher prevalence of obesity were: living in an LSE zone, low or medium SES of the household, never eating at the canteen, absence or rare breakfast intake, absence or rare light afternoon meal intake and having a high level of sedentary activity (Table 4).

For the 7–11-year-old sample, variables significantly associated (*P* < 0·05) with a higher prevalence of obesity were: female gender, low or medium SES of the household, absence or rare breakfast intake and absence of morning snack (Table 4).

Multivariate analysis

In addition to variables significantly associated with overweight in the univariate analysis (*P* < 0·05), variables with *P* < 0·20 were included in the multivariate final

model: gender and geographical area for children from the 5–7-year-old sample; LSE zone, light afternoon meal and sedentary activity for the 7–11-year-old sample. Only significant variables were presented in Table 5.

Among children from the 5–7-year-old sample, factors significantly associated with a higher risk of obesity in the final model were: low or medium SES of the household and never eating at the canteen (both *P* < 0·05; Table 5). The model was adequate: $\chi^2_{(5df)} = 0 \cdot 6$; *P* = 0·99 (Hosmer–Lemeshow goodness-of-fit test).

Among children from the 7–11-year-old sample, factors independently associated with a higher risk of obesity were: female gender, low or medium SES of the household, absence or rare intake of breakfast and absence of morning snack (all *P* < 0·05; Table 5). The model was adequate: $\chi^2_{(7df)} = 3 \cdot 8$; *P* = 0·81 (Hosmer–Lemeshow goodness-of-fit test).

Discussion

The present study shows cross-sectional association of overweight and obesity with both environmental socio-economic factors (parental SES, geographical area) and individual behaviour (eating habits, level of sedentary activity). These data reinforce previous findings but also show original associations, especially regarding the protective role of eating at the canteen and of small snacks between main meals.

In the Aquitaine region, the prevalences of overweight including obesity and obesity (respectively 9·5% and 2·2% for 5–7-year-old children and 15·6% and 2·9% for 7–11-year-old children) are slightly lower than reported in

Table 4 Factors associated with obesity in children aged 5–7 years (*n* 4048) and 7–11 years (*n* 3619): cross-sectional survey in primary schools in the Aquitaine region, France, 2007–2009

	5–7-year-old sample			7–11-year-old sample		
Variable	OR	95 % CI	*P*	OR	95 % CI	*P*
Gender						
Male (ref.)						
Female	1·3	0·9, 2·0	0·18	1·8	1·2, 2·7	0·004
Geographical area						
Urban (ref.)						
Rural	0·5	0·4, 1·1	0·11	1·0	0·7, 1·5	0·92
Zone						
Non-LSE (ref.)						
LSE	2·3	1·4, 3·8	2×10^{-3}	1·6	0·8, 3·0	0·16
Parent's SES						
High (ref.)						
Medium	1·9	1·1, 3·4	$<10^{-4}$	1·6	1·0, 2·6	0·02
Low	3·4	2·0, 6·0		2·1	1·2, 3·6	
Eating at the canteen						
Never (ref.)				Not available		
Sometimes	0·3	0·2, 0·6	6×10^{-4}			
Always	0·4	0·2, 0·7				
Breakfast						
Always (ref.)						
Never or sometimes	2·7	1·5, 5·0	10^{-3}	2·8	1·3, 6·0	0·006
Morning snack						
No (ref.)						
Yes	1·2	0·8, 0·9	0·32	0·6	0·4, 1·0	0·03
Light afternoon meal						
Always (ref.)						
Never or sometimes	2·2	1·3, 3·8	3×10^{-3}	1·6	0·9, 3·0	0·13
Nibbling						
Never or sometimes (ref.)						
Often or always	1·2	0·6, 2·3	0·65	1·2	0·7, 2·0	0·42
Sedentary activity						
Low (ref.)						
High	1·9	1·3, 3·0	2×10^{-3}	1·4	0·9, 2·1	0·09
Leisure club						
Every Wednesday (ref.)						
Never or some Wednesdays	1·3	0·6, 2·9	0·43	1·1	0·5, 2·5	0·75
Sports club						
Yes (ref.)						
No	0·8	0·5, 1·2	0·25	1·3	0·8, 1·9	0·27

Univariate logistic regression analysis.
ref., referent category; LSE, low socio-economic; SES, socio-economic status.

other studies conducted in France for 5–7-year-old children in 2000 (14 %, including 3·6 % of obese children)[23] and 7–9 year-old children in 2007 (15·8 %, including 2·8 % of obese children)[14,15] and in Western Europe[6]. Concerning gender, significantly more girls than boys were overweight (including obesity) among all children in primary schools, as shown in several French studies[17,23,24].

In both samples we found an association between overweight and obesity and low parental SES that has been widely described previously in the literature[25–28]. However, LSE zone was no longer associated with overweight and obesity in multivariate models, probably because of its high correlation with parental SES.

Concerning individual behaviours, in both samples, a high level of sedentary activity was associated with a higher risk of being overweight (including obesity), a finding previously reported elsewhere, since time spent watching television and playing video games was positively associated with childhood overweight in France and among teenagers in Aquitaine[27–29]. The absence of an association found for all children between overweight or obesity and physical activity practice (unlike previously reported[30,31]) may be partly explained by our procedure of measurement of physical activity that was based on self-reported information and that did not take into account the intensity of physical activity.

Our study also highlights the potential importance of some dietary behaviours. Lack of breakfast intake was an associated factor of overweight (including obesity) among children from the 5–7-year-old sample and of obesity among children from the 7–11-year-old sample. Indeed, children having breakfast every day had a lower risk than children who never or sometimes had breakfast. There is growing evidence of the association between regular breakfast consumption and health: breakfast intake may reduce the risk of chronic diseases due to its

Table 5 Factors associated with obesity in children aged 5–7 years (*n* 3783) and 7–11 years (*n* 3510): cross-sectional survey in primary schools in the Aquitaine region, France, 2007–2009

Variable	5–7-year-old sample			7–11-year-old sample		
	OR	95 % CI	*P*	OR	95 % CI	*P*
Gender						
Male (ref.)						
Female		Not in final model		1·9	1·3, 2·8	10^{-3}
Parents' SES						
High (ref.)						
Medium	2·0	1·1, 3·8	$<10^{-4}$	1·6	1·0, 2·5	0·03
Low	3·1	1·6, 6·0		2·0	1·2, 3·5	
Eating at the canteen						
Never (ref.)						
Sometimes	0·4	0·2, 0·7	$<10^{-4}$		Not in final model	
Always	0·5	0·3, 0·8				
Breakfast						
Always (ref.)						
Never or sometimes		Not in final model		2·6	1·1, 5·9	0·02
Morning snack						
No (ref.)						
Yes		Not in final model		0·5	0·3, 0·9	0·01

Multivariate logistic regression analysis (final model).
ref., referent category; SES, socio-economic status.

potential impact on the composition of overall diet[32,33] and also reduce the risk of becoming overweight[10,34,35].

Children from our 5–7-year-old sample eating at the canteen every day had a significantly lower risk of being obese than those who never ate at the canteen (data not available for the 7–11-year-old sample). This association between the risk of becoming obese and eating at the canteen has not previously been reported, although several studies confirm the relevance of the school canteen as a means of influencing children's eating habits[36]. Moreover, the link between eating at the canteen and SES, already found in several studies[36], does not explain our results, since the association between obesity and canteen remains after adjustment on the other variables such as SES. Moreover, there was no interaction between eating at the canteen and SES (*P* = 0·58), indicating that the protective association was observed whatever the parental socio-economic level. In France, improving the nutritional quality of meals served in school catering tends to be a priority for public health authorities[37]: nutritional recommendations (dealing with quantities and frequencies of food presentation) have been published according to the French National Nutrition and Health Program and many actions have been implemented to incite and help school catering staff to follow them.

Moreover, another original finding of our study is that children from the 5–7-year-old sample who never or rarely had a light afternoon meal after leaving school (usually around 16.00 hours, which is customary for schoolchildren in France) had a significantly higher risk of becoming overweight. The protective effect of the afternoon meal has been described previously and may be explained by a better distribution of energy intake, thus avoiding nibbling between lunch and dinner[38], but no

other study showed an independent association between afternoon meal and overweight, to our knowledge.

The current study also shows an association in children between the absence of morning snack intake and a higher risk of being overweight or obese. This may seem surprising because several studies report that morning snacks are often fatty and sweet and have a negative impact on food balance[39]. However, this could be the consequence of intervention aiming at suppressing or improving the composition of mid-morning snacks, especially in overweight or obese children. In Aquitaine, thanks to the programme 'Nutrition, Prevention and health of children and teenagers', many actions have been taken in order to stop systematic morning snacks in primary schools (5–7-year-old children), to improve their composition (by promoting the consumption of fruit, for example) and to dissuade parents from giving their child a morning snack. These recommendations have been followed relatively well in the region[40]. Thus, parents of overweight or obese children may now be aware of nutritional recommendations and the negative effects of morning snacks and so they are less likely to give them to their children, whereas parents of slim children may not necessarily feel concerned by these recommendations and are more likely to continue to give their children a morning snack. Taken altogether, our results on dietary habits suggest that a high meal frequency is associated with a lower risk of overweight or obesity.

A limitation of the present cross-sectional study is that causality cannot be inferred from our results. Nevertheless, some environmental factors such as parental SES and geographical area are clearly risk factors and not consequences of overweight and obesity. Moreover, as no dietary survey was available, analyses could not be

adjusted for total energy intake. Thus the apparently protective association with eating at the canteen and having more meals should be interpreted with caution, in the absence of detailed information on the content of these meals.

On the other hand, the main strength of the study is the large representative sample of schools selected for analysis and of the consistent data on two different age groups of the same region.

As widely described in the literature, our data confirm the importance of some environmental or individual risk factors for childhood overweight and obesity. In opposition to environmental factors such as SES or geographical area, sedentary level and eating behaviour are individual factors that can be improved thanks to educational actions. These findings reinforce the relevance of the implementation of public health programmes, such as the French National Nutrition and Health Program and that in Aquitaine. Moreover, these findings underline the importance of implementing interventions in primary schools to achieve consistent behavioural changes, as recommended by recent international[1,41], national[12,42] and regional policies.

Acknowledgements

References

1. World Health Organization (2006) *Addressing the Socio-economic Determinants of Healthy Eating Habits and Physical Activity Levels Among Adolescents.* Geneva: WHO.
2. Flaherman V & Rutherford GW (2006) A meta-analysis of the effect of high weight on asthma. *Arch Dis Child* **91**, 334–339.
3. Bibbins-Domingo K, Coxson P, Pletcher MJ *et al.* (2007) Adolescent overweight and future adult coronary heart disease. *N Engl J Med* **357**, 2371–2379.
4. Taylor ED, Theim KR, Mirch MC *et al.* (2006) Orthopedic complications of overweight in children and adolescents. *Pediatrics* **117**, 2167–2174.
5. Jolliffe D (2004) Extent of overweight among US children and adolescents from 1971 to 2000. *Int J Obes Relat Metab Disord* **28**, 4–9.
6. Lobstein T & Frelut ML (2003) Prevalence of overweight among children in Europe. *Obes Rev* **4**, 195–200.
7. Wang Y, Monteiro C & Popkin BM (2002) Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China, and Russia. *Am J Clin Nutr* **75**, 971–977.
8. Moschonis G, Tanagra S, Vandorou A *et al.* (2010) Social, economic and demographic correlates of overweight and obesity in primary-school children: preliminary data from the Healthy Growth Study. *Public Health Nutr* **13**, 1693–1700.
9. Shrewsbury V & Wardle J (2008) Socioeconomic status and adiposity in childhood: a systematic review of cross-sectional studies 1990–2005. *Obesity (Silver Spring)* **16**, 275–284.
10. Haug E, Rasmussen M, Samdal O *et al.* (2009) Overweight in school-aged children and its relationship with demographic and lifestyle factors: results from the WHO-Collaborative Health Behaviour in School-aged Children (HBSC) study. *Int J Public Health* **54**, Suppl. 2, 167–179.
11. Lioret S, Touvier M, Lafay L *et al.* (2008) Dietary and physical activity patterns in French children are related to overweight and socioeconomic status. *J Nutr* **138**, 101–107.
12. Hercberg S, Chat-Yung S & Chauliac M (2008) The French National Nutrition and Health Program: 2001–2006–2010. *Int J Public Health* **53**, 68–77.
13. Girardet JP, Bocquet A, Bresson JL *et al.* (2009) French national program for nutrition and health: effects on children's health. *Arch Pediatr* **16**, 3–6.
14. Rolland-Cachera MF, Castetbon K, Arnault N *et al.* (2002) Body mass index in 7–9-y-old French children: frequency of obesity, overweight and thinness. *Int J Obes Relat Metab Disord* **26**, 1610–1616.
15. Salanave B, Peneau S, Rolland-Cachera MF *et al.* (2009) Stabilization of overweight prevalence in French children between 2000 and 2007. *Int J Pediatr Obes* **4**, 66–72.
16. Peneau S, Salanave B, Maillard-Teyssier L *et al.* (2009) Prevalence of overweight in 6- to 15-year-old children in central/western France from 1996 to 2006: trends toward stabilization. *Int J Obes (Lond)* **33**, 401–407.
17. Institut de veille sanitaire (2006) *National Nutrition and Health Survey (ENNS), 2006: Nutritional Situation in France in 2006 According to Objective Indicators and Guidelines of the National Nutrition and Health Program (PNNS).* Paris: InVS.
18. Thibault H, Boulard S, Carriere C *et al.* (2009) Prevention of childhood overweight and obesity program of Aquitaine region, France. *Arch Pediatr* **16**, 570–572.
19. Cole TJ, Bellizzi MC, Flegal KM *et al.* (2000) Establishing a standard definition for child overweight and obesity worldwide: international survey. *Br Med J* **320**, 1240–1243.
20. Institut national de la statistique et des études économiques (2003) *Classifications of Occupations and of Social and Occupational Categories of Salaried Employees.* Paris: INSEE.
21. Ministère de l'Education nationale (1981) Priority zones and priority education programs. *Bull Officiel spécial*, no. 1, 6–10.
22. Ministère de l'Education nationale (1981) Primary and secondary educations: priority zones. *Bull Officiel* **27**, 2077–2079.
23. Duport N, Castetbon K, Guignon G *et al.* (2003) Corpulence des enfants scolarisés en grande section de maternelle en France métropolitaine et départements d'outre-mer: variations régionales et disparités urbaines. *BEH* **18–19**, 73–88.

24. Agence Française de Sécurité Sanitaire des Aliments (2009) *Étude Individuelle Nationale des Consommations Alimentaires 2 (INCA 2) (2006–2007)*. Maisons-Alfort: AFSSA.

25. Agras WS, Hammer LD, McNicholas F *et al.* (2004) Risk factors for childhood overweight: a prospective study from birth to 9.5 years. *J Pediatr* **145**, 20–25.

26. Baird J, Fisher D, Lucas P *et al.* (2005) Being big or growing fast: systematic review of size and growth in infancy and later obesity. *BMJ* **331**, 929.

27. Thibault H, Contrand B, Saubusse E *et al.* (2010) Risk factors for overweight and obesity in French adolescents: physical activity, sedentary behavior and parental characteristics. *Nutrition* **26**, 192–200.

28. Tremblay MS, Leblanc AG, Kho ME *et al.* (2011) Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *Int J Behav Nutr Phys Act* **8**, 98.

29. Lioret S, Maire B, Volatier JL *et al.* (2007) Child overweight in France and its relationship with physical activity, sedentary behaviour and socioeconomic status. *Eur J Clin Nutr* **61**, 509–516.

30. Janssen I, Katzmarzyk PT, Boyce WF *et al.* (2005) Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns. *Obes Rev* **6**, 123–132.

31. Trost SG, Kerr LM, Ward DS *et al.* (2001) Physical activity and determinants of physical activity in obese and non-obese children. *Int J Obes Relat Metab Disord* **25**, 822–829.

32. Vereecken C, Dupuy M, Rasmussen M *et al.* (2009) Breakfast consumption and its socio-demographic and lifestyle correlates in schoolchildren in 41 countries participating in the HBSC study. *Int J Public Health* **54**, Suppl. 2, 180–190.

33. Giovannini M, Agostoni C & Shamir R (2010) Symposium overview: do we all eat breakfast and is it important? *Crit Rev Food Sci Nutr* **50**, 97–99.

34. Rampersaud GC, Pereira MA, Girard BL *et al.* (2005) Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. *J Am Diet Assoc* **105**, 743–760.

35. Tin SP, Ho SY, Mak KH *et al.* (2011) Breakfast skipping and change in body mass index in young children. *Int J Obes (Lond)* **35**, 899–906.

36. Finch M, Sutherland R, Harrison M *et al.* (2006) Canteen purchasing practices of year 1–6 primary school children and association with SES and weight status. *Aust N Z J Public Health* **30**, 247–251.

37. Lafay L, Volatier JL & Martin A (2002) School catering in the INCA study (2nd part: School meals: nutritional and food composition, and impact on nutritional intake of children). *Cah Nutr Diet* **37**, 395–404.

38. Bellisle F, Rolland-Cachera MF, Deheeger M *et al.* (1988) Obesity and food intake in children: evidence for a role of metabolic and/or behavioral daily rhythms. *Appetite* **11**, 111–118.

39. Bocquet A, Bresson JL, Briend A *et al.* (2003) The morning snack at school is inadequate and unnecessary. *Arch Pediatr* **10**, 945–947.

40. Thibault H, Carriere C, Langevin C *et al.* (2010) Morning snack offer in primary school: outlook and practices in Aquitaine, France, between 2004 and 2008. *Arch Pediatr* **17**, 1516–1521.

41. World Health Organization (2003) *Diet, Nutrition and the Prevention of Chronic Diseases*. Geneva: WHO.

42. Girardet JP, Bocquet A, Bresson JL *et al.* (2009) Le programme national nutrition santé (PNNS): quels effets sur la santé des enfants? *Arch Pediatr* **16**, 3–6.