



## Applied nutritional investigation

# Risk factors for overweight and obesity in French adolescents: Physical activity, sedentary behavior and parental characteristics

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**Abstract**

**Objective:** We determined the prevalence by age and sex and associated factors of overweight and obesity in French adolescents.

**Methods:** We conducted a cross-sectional study of 2385 adolescents aged 11–18 y (1213 boys and 1172 girls) from middle and high schools in the Aquitaine region (southwest France) in 2004–2005. Weight and height were measured, and adolescents filled in a questionnaire about their characteristics and those of their parents. Overweight and obesity were defined according to the age- and sex-specific body mass index cutoff points of the International Obesity Task force.

**Results:** Prevalence of overweight (obesity included) was greater in boys and younger children. The odds ratio (OR) for an adolescent being overweight increased with parents' being overweight (at least one parent overweight, OR 1.97, 1.48–2.62,  $P < 0.0001$ ), low paternal socioeconomic status (OR 1.78, 1.22–2.60,  $P < 0.01$ ) and sedentary behavior (22 h/wk, OR 1.33, 1.02–1.74,  $P < 0.05$ ), and decreased with physical activity of parents (at least one parent active, OR 0.67, 0.51–0.89,  $P = 0.01$ ).

**Conclusion:** Our data support the hypothesis that parental overweight and low socioeconomic status and adolescents' sedentary behavior are strong risk factors for adolescent overweight and obesity, and that parents active lifestyle is associated with a lower risk of overweight in their adolescents. © 2009 Elsevier Inc. All rights reserved.

**Keywords:**

Adolescents; Overweight; Obesity; Physical activity; Risk factors

**Introduction**

Overweight and obesity in childhood and adolescence have dramatically increased over the past few years in developed countries [1–3] and, to some degree, in other parts of the world [4]. Their prevalence has risen three-fold in many European countries since the 1980s. Obesity is an established risk factor for several chronic diseases [5–8]. In 1998, the World Health Organization recognized obesity as a major public health epidemic [9]. Obesity is a multifactorial problem, resulting from rapidly changing social, economic, and

physical environments that have led to an energy imbalance in the population through a dramatic reduction in physical activity [10,11] and changes in dietary patterns [4,12]. Thus, principal risk factors for childhood overweight include parental obesity, socioeconomic status (SES), physical activity, sedentary behavior, and diet [2,3,8,10,13–15].

Recent French data have shown that frequencies of overweight including obesity were 15% for 3- to 14-y-old children and 18.1% for 7- to 9-y-old French children [16,17]. These French data are comparable to those reported in other studies conducted in Western Europe [2].

The French National Program on Nutrition and Health was launched by the ministry of health in 2001. One of its main objectives is to stop the increase in the prevalence of childhood obesity in France. Various public health actions regarding the improvement of dietary habits and physical activity in children were implemented [18,19] in the Aquitaine region (southwest France); a multidisciplinary public

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health program was launched in November 2004 to improve the behavior of children and teenagers regarding diet and physical activity and to stabilize the prevalence of childhood obesity. Before implementing the program, various studies were conducted to guide the intervention and to provide baseline data to evaluate its impact on dietary habits, lifestyle, overweight, and obesity.

One of these studies sought to estimate overweight and obesity prevalence and to identify factors, particularly physical activity and sedentary behavior but also social and parental factors, that might be associated with overweight and obesity in a sample of adolescents aged 11–18 y to propose adapted action. This article reports the main results of that survey.

## Materials and methods

### *Design and subjects*

The study was performed in a representative sample of middle and high school students from the Aquitaine region from November 2004 to January 2005. Subjects were selected from the population of adolescents attending public middle and high schools. Schools were selected on the basis of SES of an area, rural or urban, and willingness of sports teachers to participate in the study. Thus, 49 of the 536 middle and high schools in Aquitaine were invited to participate in the study. For each school, participating students were selected using stratification by grade to form a panel of classes of middle and high school students to study the prevalence of overweight and obesity, physical activity, and sedentary behavior according to sex and age. Prior consent for participation was obtained from the children's parents.

### *Measurements*

Weight and height were measured and recorded for each student by school nurses. A 99-item self-report questionnaire was completed by students during class under supervision of physical education teachers. It included information about sex, age, grade level, amount of time spent doing different kinds of physical activities, amount of time spent playing video games or using a computer, amount of time spent watching television, professional occupation of the father, physical activity habits of the parents, and parental weight status.

### *Definitions*

#### *Body mass index measurements and overweight classification*

Body mass index (BMI) was calculated as weight (kilograms) divided by height (meters) squared. The international age- and gender-specific child cutoff points of the International Obesity Task Force (IOTF) [20] were used to define

overweight and obesity. At the age of 18 y, the IOTF values for “overweight” and “obese” correspond to BMIs of 25 and 30 kg/m<sup>2</sup>, respectively.

### *Physical activity*

Physical activity was determined from the number of weekly hours the adolescents reported doing “exercise or sports.” The adolescents were asked to report separately how many hours they spent every week in different types of physical activities: at school during physical education (lessons), at sports clubs, and during their free time. The answers were summed to create a total cumulative weekly time spent on physical activity.

### *Sedentary behavior*

Sedentary activity was estimated by weekly time of screen viewing. To do this, the adolescents were asked to report separately how many hours they spent watching television, using a computer, and playing video games on a usual school day and a usual weekend day. Usual weekly time of screen viewing was calculated and summed to create a total cumulative weekly time spent on screen viewing that we called *sedentary behavior*.

### *Socioeconomic status*

Socioeconomic status was assessed according to the professional occupation of the father. Three work categories were defined: “high,” including managers and executives, independent professionals (such as lawyers, practitioners, accountants, etc.), and teachers; “medium” (craftsmen, tradesmen, shopkeepers, proprietary business owners, office workers, employees, farmers, and land-holders); and “low” (manual workers and others (retired, unemployed, etc.)).

### *Physical activity habits of parents and parental weight status*

Although these concerned parents, these items were filled in by adolescents and were formulated as follows: “Does your father or mother have an overweight problem?” and “Does your father or mother practice physical activity (sport or leisure) on a regular basis?”

### *Rural and urban areas*

In France, according to the National Institute for Statistics and Economic Studies, an urban area is a continuously built-up area of 2000 persons or more. A built-up area is an area where the distance between dwellings is shorter than 200 m. Rural populations are all those not classified as urban.

### *Statistical analysis*

Data were analyzed using SAS 8.0 (SAS Institute, Cary, NC, USA). For continuous variables, results are expressed

as means and standard deviations (SDs). Differences between groups were assessed by chi-square tests or the Kruskal-Wallis test.  $P < 0.05$  was considered statistically significant. Univariate analyses examined the association of child and parent variables with overweight (obesity included) and obesity alone as the dependent variable, using chi-square tests to determine statistical significance. Variables found to be significant at the univariate stage at  $P \leq 0.25$  were then entered into a logistic regression analysis using the same dependent variables.

## Results

Of the 49 middle and high schools invited to participate in the study, six declined to participate (response rate 88%). Questionnaires were filled out by 2533 students. We included 2385 adolescents aged 11–18 y (1213 boys and 1172 girls) and excluded 148 (5.8%) adolescents younger than 11 or older than 18 y to have homogeneous age groups. This sample composed of 1390 adolescents from middle schools (664 girls and 726 boys) and of 995 adolescents from high schools (508 girls and 487 boys) is representative of the students of middle and high schools for each school grade according to the data of the French ministry of education.

### Overweight and obesity prevalence

Of the 2385 adolescents aged 11–18 y, 13.6% were overweight, including obesity (11.7% were overweight and 1.9% were obese), with variations according to age and gender (Fig. 1). The percentage of overweight (obesity included) adolescents was significantly higher for the younger students ( $P < 0.001$ ; Table 1). In general, boys were more often overweight (obesity included) than girls ( $P < 0.01$ ; Table 1).

### Physical activity

Physical activity declined with increasing age. Weekly time of cumulative physical activity (including sports clubs, free-time activity, and school-based physical education) decreased from 9 h for children aged 11 y to 6 h for adolescents aged 18 y (Fig. 2). Mean weekly time of cumulative physical activity was higher for boys than girls ( $8.9 \pm 4.8$  versus  $6.3 \pm 4$  h,  $P < 10^{-4}$ ; Fig. 2). It was significantly higher for adolescents from the higher SES based on the professional occupation of the father ( $8.25 \pm 4.9$ ,  $7.6 \pm 4.5$ , and  $7.25 \pm 4.5$  h from the highest to the lowest SES,  $P < 10^{-3}$ ).

### Physical activity during school hours

Physical activity during school hours decreased with increasing age, from 4 h/wk at the beginning of middle school to 2 h/wk during high school (Fig. 2). There was no difference according to gender. Nevertheless, girls were more often exempted from physical education than boys (2.4% versus 0.8%,  $P = 0.001$ ).

### Physical activity during leisure time

More boys than girls (80.8% versus 66.8%) declared engaging in physical activity during leisure time. The average number of hours spent on this activity decreased with age, especially in girls (Fig. 2).

### Physical activity in a sports club

The proportion of subjects training in a sports club was greater among boys than girls at all ages ( $P < 0.05$ ). The percentage declined with age (64.6% for children aged 11 y versus 42.2% for adolescents aged 18 y), especially in girls.

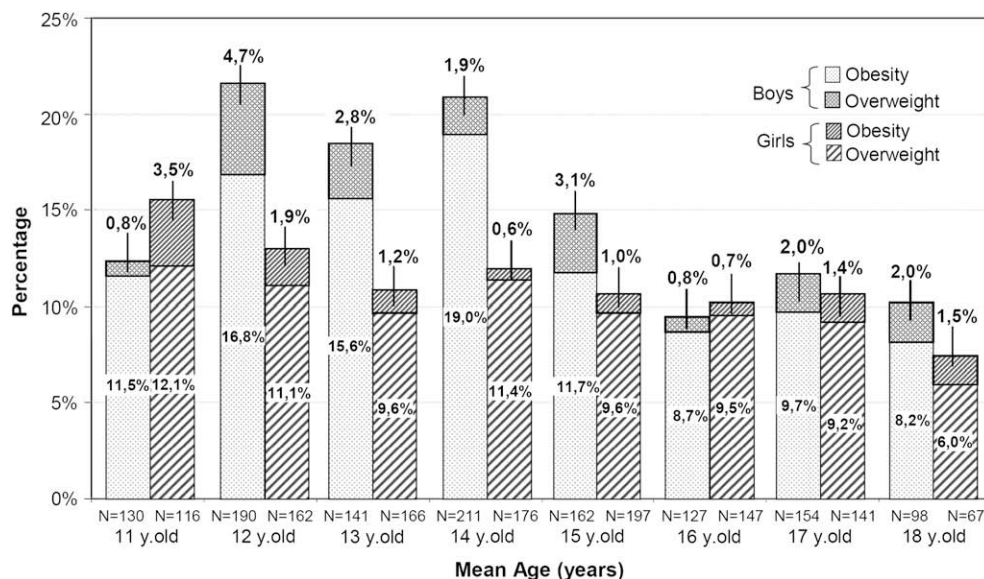


Fig. 1. Prevalence of overweight and obesity in adolescents according to age and sex in the sample of middle and high school students of the Aquitaine region, France ( $n = 2385$ )

Table 1  
Overweight and obesity prevalence (International Obesity Task Force references) according to characteristics of adolescents and parents

	Overweight (obesity included)	<i>P</i>	Obesity	<i>P</i>
Gender		<0.01		0.07
Boys ( <i>n</i> = 1213)	15.8%		2.4%	
Girls ( <i>n</i> = 1172)	11.4%		1.4%	
Age (y)		<0.001		0.27
11–14 ( <i>n</i> = 1292)	15.9%		2.2%	
15–18 ( <i>n</i> = 1093)	11.0%		1.6%	
Physical activity		0.28		0.92
Only at school ( <i>n</i> = 426)	12.0%		1.9%	
Outside school ( <i>n</i> = 1940)	14.0%		1.8%	
Hours of physical activity per week		0.25		0.80
<7 ( <i>n</i> = 1160)	12.8%		1.9%	
≥7 ( <i>n</i> = 1197)	14.4%		1.7%	
Hours of sedentary activity per week		<0.01		<0.001
<22 ( <i>n</i> = 1182)	11.4%		0.9%	
≥22 ( <i>n</i> = 1203)	15.8%		2.8%	
Weight status of parents		<0.0001		<0.01
Neither parent overweight ( <i>n</i> = 1875)	11.9%		1.5%	
≥1 parent overweight ( <i>n</i> = 510)	19.8%		3.3%	
Physical activity of parents		<0.001		<0.05
Neither parent active ( <i>n</i> = 1276)	15.8%		2.5%	
≥1 parent active ( <i>n</i> = 1109)	11.1%		1.2%	
Socioeconomic status		<0.01		0.58
High ( <i>n</i> = 548)	9.5%		1.5%	
Medium ( <i>n</i> = 1037)	14.2%		2.2%	
Low ( <i>n</i> = 572)	16.6%		1.9%	
Residence		0.06		0.57
Rural ( <i>n</i> = 619)	15.8%		1.6%	
Urban ( <i>n</i> = 1668)	12.8%		2.0%	

However, for subjects training in a sports club, mean weekly time of practice increased from  $3.6 \pm 2.5$  h at age 11 to  $5.4 \pm 2.4$  h at age 18. Therefore, in the entire sample (includ-

ing subjects not affiliated to a sports club), the trend for the mean time of practice in a sports club did not change with age. Sports practiced in clubs were different according to

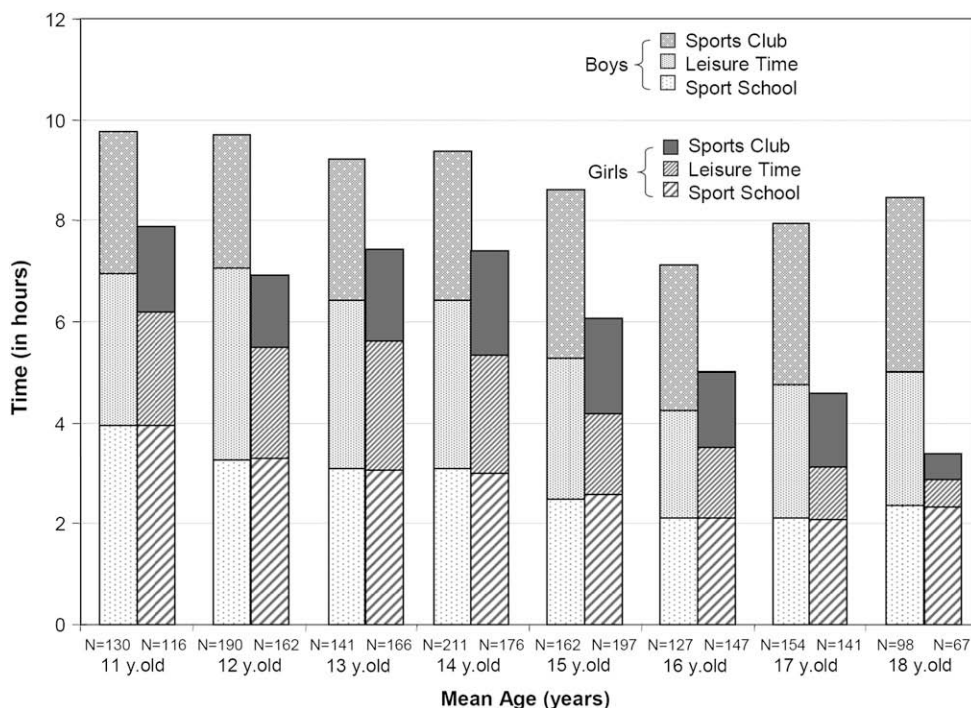


Fig. 2. Weekly hours of physical activity of adolescents by type of physical activity, age, and sex in the sample of middle and high school students in the Aquitaine region, France (*n* = 2385).

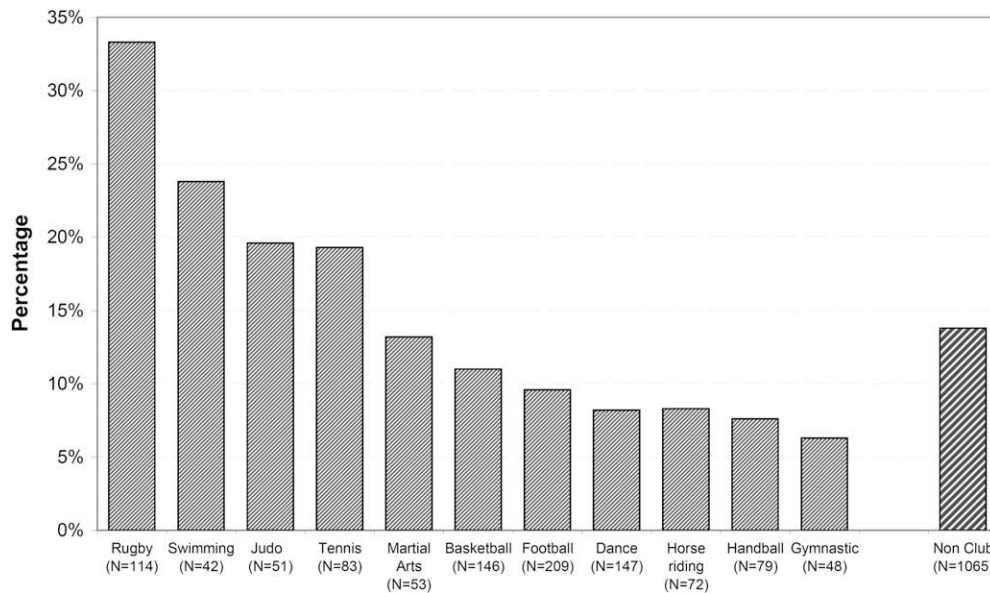


Fig. 3. Prevalence of overweight (obesity included) of adolescents according to type of sports in the sample of middle and high school students in the Aquitaine region, France ( $n = 2385$ ).

gender. The most popular sports for boys were soccer (27%), rugby (14%), and basketball (11%), and those for girls were dancing (25%), basketball (12%), and horse-riding (12%). There was no difference in the frequency of overweight and obesity between subjects practicing sport in a club (13.4%) and those who did not (13.8%,  $P = 0.76$ ), but frequency of overweight and obesity were different according to the type of sport (Fig. 3). A higher frequency of overweight (obesity included) was found in rugby players (33.3%) and in individuals practicing swimming (23.8%), judo (19.6%), and tennis (19.3%). Similarly, soccer, dancing, horse-riding, and gymnastics were associated with a lower frequency of overweight (obesity included; Fig. 3).

#### Sedentary behavior

Mean weekly time spent on sedentary activity (watching television, playing video games, and using a computer) was  $25 \pm 15.1$  h. There was a significant difference in screen time by gender ( $26.8 \pm 15.7$  h for boys versus  $23.3 \pm 14.3$  h for girls,  $P < 10^{-4}$ ; Fig. 4). This difference was due to time spent playing video games and using a computer ( $12.5 \pm 10.7$  h for boys versus  $8.1 \pm 8.6$  h for girls,  $P < 10^{-4}$ ). Mean weekly time spent on sedentary activity was significantly lower in adolescents from the higher SES based on the professional occupation of the father ( $P < 0.002$ ). Nevertheless, no significant difference with regard to age was observed.

#### Univariate and logistic regression analyses

Univariate analysis revealed a significant association ( $P < 0.05$ ) between being overweight (including obesity) and gender, age, sedentary activity, physical activity of

parents, weight status of parents, and SES but not time in physical activity, but significance was borderline for place of residence (rural versus urban; Table 1). The same variables except age and SES were also associated with obesity risk. All these significant variables were entered into the logistic regression analysis to estimate the relative risk of overweight (obesity included) or obesity (Table 2).

The analysis showed that being male, being younger, being from a lower or medium socioeconomic background, having overweight parents, and having longer sedentary behavior significantly increased the risk of overweight and/or obesity. Having overweight parents and having longer sedentary behavior significantly increased the risk of obesity. Having at least one parent practicing a sport was found to be a significant protective factor against overweight (including obesity) and obesity, but not the adolescent's time spent in physical activity.

#### Discussion

This study shows that the prevalence of overweight and obesity in these adolescents from middle and high schools in southwest France is situated in the average range of that reported in other studies conducted in Western Europe [2,21,22]. Logistic regression analysis revealed associations among overweight, obesity, and specific characteristics of the subjects or their lifestyle, such as the known link with sedentary activity [13,23]. However, we did not find any association between overweight or obesity and physical activity.

The main finding of this study is not only the importance of the role of environmental and especially parental factors such as the SES of the father and parental weight status, which have been previously described [14,24], but also

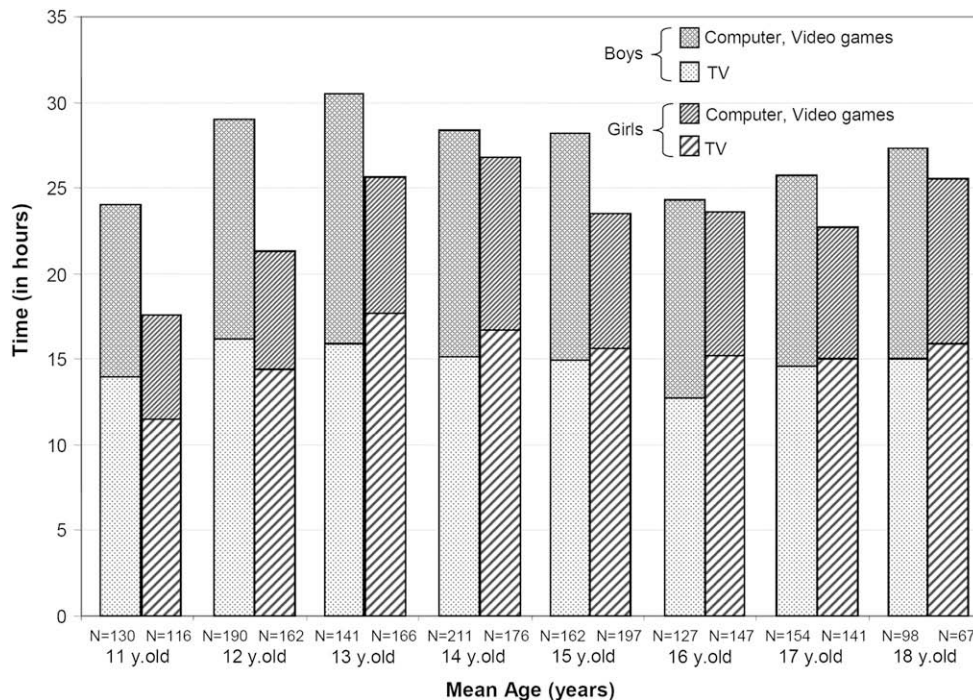


Fig. 4. Weekly time spent in front of a screen (television plus computer) by adolescents according to age and sex in the sample of middle and high school students in the Aquitaine region, France ( $n = 2385$ ).

parental lifestyle regarding physical activity, which is a less well-known characteristic. The subjects had a high level of sedentary behavior with a mean of 25 h/wk viewing televi-

sion or playing video games or using a computer. Boys spent more time in sedentary behavior than girls, especially playing video games as usually reported [13,25–27]. As

Table 2  
Predictive factors of overweight (including obesity) and obesity by logistic regression analysis

	Overweight (obesity included)		Obesity	
	Adjusted OR (95% CI)	P	Adjusted OR (95% CI)	P
Sex				
Girls	Ref (1.00)		Ref	
Boys	1.43 (1.08–1.88)	<0.05	1.51 (0.75–3.01)	0.24
Age (y)				
11–14	Ref		Ref	
15–18	0.62 (0.47–0.82)	<0.001	0.75 (0.38–1.48)	0.41
Physical activity				
<7 h/wk	Ref		Ref	
≥7 h/wk	1.10 (0.84–1.45)	0.48	0.79 (0.45–1.81)	0.79
Sedentary activity				
<22 h/wk	Ref		Ref	
≥22 h/wk	1.33 (1.02–1.74)	<0.05	2.52 (1.20–5.25)	<0.05
Weight status of parents				
Neither parent overweight	Ref		Ref	
≥1 parent overweight	1.97 (1.48–2.62)	<0.0001	2.56 (1.31–4.99)	<0.01
Physical activity of parents				
Neither parent active	Ref		Ref	
≥1 parent active	0.67 (0.51–0.89)	<0.01	0.51 (0.24–1.05)	0.07
Socioeconomic status				
High	Ref		Ref	
Medium	1.44 (1.01–2.05)	<0.05	1.40 (0.58–3.35)	0.46
Low	1.78 (1.22–2.60)	<0.01	1.07 (0.39–2.89)	0.90
Residence				
Urban	Ref		Ref	
Rural	1.23 (0.93–1.64)	0.14	0.93 (0.44–1.94)	0.84

CI, confidence interval; OR, odds ratio; Ref, reference group

expected [23], there was a significant link between sedentary behavior and overweight (obesity included) that was stronger with obesity than with overweight. Physical activity declined with age, girls spent less time than boys practicing physical activity, and the sports practiced were different according to gender. These results are consistent with other studies [10,11,28–32]. However, we did not find any relation between physical activity and overweight (including obesity), for total weekly time of physical activity, when differentiating students practicing physical activity outside of school or not, or selecting adolescents affiliated to sports clubs or not. In fact, the influence of physical activity on body weight and body fat in adolescents is controversial, with several studies indicating that overweight status is inversely related to physical activity [33–35] and others reporting no association [36,37]. These data are consistent with several studies reporting that associations are often stronger between watching television and obesity than those relating BMI to time spent exercising [38]. In our study, the lack of a relation between physical activity and overweight and obesity does not mean for several reasons that this relation does not exist. First, it is known that measurement of physical activity is difficult and subject to error. Our procedure was based only on self-reported information and we only reported time spent doing physical activity without assessing the intensity of physical activity, which is known to be important [39,40]. Second, overweight and obesity were evaluated using BMI, which may not be adapted for adolescents training intensively [41]. Because we did not really measure body composition, a high BMI could potentially represent a high muscle mass rather than fat. Third, the prevalence of overweight (obesity included) was different according to the sport practiced. For example, in the southwest of France, about 11% of adolescents play rugby in clubs and have a higher prevalence of overweight and/or obesity (33%) than other adolescents, regardless of whether they are affiliated to sport clubs. Self-selection of heavier subjects to play rugby probably contributes to this finding [42]. Moreover, rugby, which involves repeated physical contact, encourages adolescents to maintain a high BMI as a playing advantage. In addition, it is possible that in our sample, overweight and physical inactivity were underestimated in the older students, who were mainly from high schools and not from professional schools.

This study also emphasizes the influence of environmental and especially parental characteristics in adolescents' obesity. Although the questionnaire was filled in by children whose answers may not always reflect the exact level of parents' weight or physical activity, it seems likely that these adolescents aged 11–18 y were able to give a reliable answer on these items. Overweight parents was the most important risk factor for overweight and/or obesity, even if the relative contributions of genes and inherited lifestyle factors to the parent–child fatness association remain unclear. Adolescents from the lower SES were more often overweight and had more risk factors by spending more time in sedentary

behavior and less time undertaking physical activity. The inverse relation between SES of parents and overweight (obesity included) that we found is consistent with previous findings [43,44].

One of the most interesting findings in this study is the association between adolescents' overweight and their parents' level of physical activity, although we did not find any direct relation with their own level of physical activity. This is further testimony to the interaction between the lifestyle of adolescents and that of their parents [40]. However, a limitation of our study is its cross-sectional design, which does not allow causality to be inferred from the observed associations. A follow-up study would allow the impact of the intervention on dietary habits, lifestyle, behavior, overweight, and obesity to be assessed.

## Conclusion

In summary, this study of adolescents in southwest France shows that parental low SES and overweight are strong risk factors for adolescent overweight (including obesity), as is adolescents' sedentary behavior. Conversely, physical activity in parents has a protective effect against overweight in their adolescents. Thus it is clear that the implementation of interventions of programs in schools such as the present one in southwest France is essential but not sufficient [45]. Because adolescents spend only a limited part of their time at school, their family and leisure environment determine their diet and physical activity levels. As a consequence, campaigns that are coherent and complementary with the action taken in schools are necessary to achieve consistent behavioral changes, as recommended by recent international policies [4,46] and by the French National Program on Nutrition and Health [18,19]. Clinicians should be involved, too, to promote and participate in efforts to educate children and parents by means of ongoing anticipatory guidance, not only about healthy dietary but also about activity habits [47], and should work together with school doctors and school nurses. They should keep encouraging all children to practice physical activity and sports regardless of their weight status.

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