

Short Communication

Prevalence of overweight, obesity, underweight and normal weight in French youth from 2009 to 2013

Jérémy Vanhelst^{1,2,3,*}, Jean-Benoît Baudelet², Paul S Fardy⁴, Laurent Béghin^{1,2}, Jacques Mikulovic³ and Zékya Ulmer⁵

¹Université de Lille, Inserm, CHU Lille, U995 – LIRIC – Lille Inflammation Research International Center, F-59000 Lille, France: ²Université de Lille, Inserm, CHU Lille, CIC 1403 – Centre d'Investigation Clinique, F-59000 Lille, France: ³Laboratoire 'LACES', Université de Bordeaux, Bordeaux, France: ⁴Queens College, City University of New York, Flushing, NY, USA: ⁵Fédération Nationale Mutualité Française, Paris, France

Submitted 11 May 2016: Final revision received 26 October 2016: Accepted 2 November 2016: First published online 28 December 2016

Abstract

Objective: To determine the prevalence of underweight, overweight and obesity in French youth from 2009 to 2013 and to determine if there are differences in weight categories according to socio-economic status.

Design: Cross-sectional study performed in different regions of France. Physical measures included weight, height and BMI. Underweight, overweight and obesity were defined according to age- and sex-specific BMI cut-off points from the International Obesity Task Force.

Setting: France.

Subjects: Children and adolescents (n 9670; 4836 boys, 4834 girls) from the French national BOUGE Program between 2009 and 2013.

Results: The prevalence of obesity was higher in boys than girls ($P < 0.05$). In contrast, underweight was more prevalent in girls ($P < 0.05$). Although there were no significant changes in overweight or underweight boys or girls from 2009 to 2013, there was a significant increase in obesity in boys and girls ($P < 0.05$) during the same time period. The prevalence of underweight increased in girls from 12.0 to 16.7% ($P > 0.05$) and remained unchanged in boys (7.1–7.3%) between 2009 and 2013. Overweight and obesity were higher in low socio-economic families ($P < 0.0001$).

Conclusions: Findings suggest that the prevalence of overweight was stable although high in French children and adolescents, while the prevalence of obesity increased significantly. Changes in underweight, although not significant, were high in girls and merit further attention. Improving public health interventions, especially in high-risk low socio-economic populations, may help to modify the behaviour that contributes to underweight, overweight and obesity in young boys and girls.

Keywords
Prevalence
Obesity
Underweight
Youth
Public health

Overweight and obesity are associated with increased body fat, a consequence of positive energy balance over a prolonged period of time that occurs when energy intake exceeds energy expenditure⁽¹⁾. Recent studies suggest that the prevalence of overweight and obesity is high, although stable, in children and adolescents^(2–4). The prevalence of underweight, however, is high and continues to increase^(5–7). Overweight and obesity in youth are associated with type 2 diabetes, metabolic syndrome, poor quality of life, lower physical fitness and self-esteem, and, in later life, with

increased risk of CHD and cancer^(8–11). Underweight in children and adolescents is associated with a poor quality of life, lower physical fitness, amenorrhea, decreased bone mineral content, negative body image and fatigue, and, in later life, with increased mortality^(12–16).

Monitoring underweight, overweight and obesity in children and adolescents is essential for accurate tracking and to evaluate the effectiveness of public health recommendations and intervention programmes. Studies of French children and adolescents found that overweight

*Corresponding author: Email jeremy.vanelst@chru-lille.fr

and obesity were stable between 1996 and 2006, although data were limited to Central and Western France⁽¹⁷⁾. To our knowledge, obesity and overweight have not been updated in France since 2009. Furthermore, few data are available on the prevalence of underweight in French children and adolescents⁽¹⁸⁾. Previous studies reported a prevalence of underweight of 7 and 15% in French boys and girls, respectively, in 2006⁽¹⁸⁾.

The purpose of the present study was to measure the prevalence of underweight, overweight and obesity in French children and adolescents from 2009 to 2013, to compare the results with findings prior to 2009 and to measure differences in weight categories according to socio-economic status (SES).

Methods

Study design

Data for the present study are from the French health promotion campaign 'Move, a priority for your health' (<http://www.bougetasante.fr/>), the BOUGE Program. The objectives of BOUGE were to: (i) assess physical fitness of children and adolescents; and (ii) promote the benefits of physical activity and physical fitness on the health of youths aged 9–16 years in French schools (<http://www.bougetasante.fr/>). The programme was developed by a French health-care organization (Fédération Nationale Mutualité Française; <http://www.mutualite.fr/>) and the National School Sport Union (Union Nationale du Sport Scolaire; <http://unss.org/>) and consisted of two days during the school year; one day to assess physical fitness (including anthropometric characteristics) and the second day to promote the health benefits of physical activity. Children and adolescents participating in the BOUGE Program were assessed only one time during the study. Each year a different group of students was measured. The study was approved by a research ethics committee (CPP Nord-Ouest IV, Lille, France). All procedures were performed in accordance with the Helsinki Declaration of 1975 as revised in 2008 and the European Good Clinical Practices. As the study did not involve an intervention and data were collected retrospectively by the study organizational structure (<http://www.mutualite.fr/>), the study was approved by the research ethics committee (CPP Nord-Ouest IV, Lille, France) as an epidemiological study. In this context, written informed consent was not required according to French human research regulations. Data collection was approved by the French National Commission of the Informatics Personal Data (Commission Nationale Informatique et Liberté).

A manual of operations was developed for teachers and participants in order to standardize test procedures (http://eps-bergpfad.fr/Sante_Bouge_Sommaire.html). Included in the manual were rationale of the study, test procedures and how data were collected. Teachers recorded test

results into an electronic data system provided by the trial sponsor. An audit of the complete data set was performed and the aberrant data were excluded.

Data were collected in sixteen regions of France in 101 schools. All schools in France were invited to participate in the study. Each school director decided whether or not to participate. If the school agreed to participate, the students aged between 9 and 16 years were invited to participate. In total, 12 082 adolescents (6107 girls, 5975 boys) volunteered to participate. Of this number, 9670 were included in the present study; 2412 adolescents were excluded because of missing or incomplete data.

Measurements

Anthropometric measures

Weight and height, respectively, were measured in shorts and T-shirts without shoes to the nearest 0.1 kg using an electronic scale and the nearest 0.1 cm using a standard physician's scale in a private room. BMI, a valid estimate of body fatness in children and adolescents⁽¹⁹⁾, was calculated from weight divided by the square of height (kg/m^2). Underweight, overweight and obesity were assessed using international age- and sex-specific cut-off points^(20,21).

Socio-economic status

The Human Development Index (HDI), developed by the United Nations Development Programme (<http://hdr.undp.org/en>), was used to assess SES of the family living in a city. The HDI considers the following factors: (i) a long and healthy life: life expectancy at birth; (ii) education index: mean years of schooling and expected years of schooling; and (iii) standard of living: gross income per capita. A city scores higher HDI when the life expectancy at birth is longer, the education period is longer and the income per capita is higher. The HDI score was collected using the zip code of the school (www.insee.fr).

Statistical analysis

Data are presented as percentage for categorical variables and as mean and standard deviation for continuous variables. Normality of the distribution was checked graphically and by using the Shapiro–Wilk test.

Comparisons of underweight, overweight and obesity between boys and girls were assessed by the χ^2 test. Changes in underweight, overweight and obesity from 2009 to 2013 were assessed using the Cochran–Armitage trend test. ANOVA was used to compare SES among different BMI categories (underweight, overweight and obesity).

All statistical tests were performed at the two-tailed α level of 0.05. Data were analysed using the statistical software package IBM SPSS Statistics for Windows, Version 22.0 and Microsoft[®] Excel 2010.

Results

Mean height, weight, BMI and prevalence rates of underweight, overweight and obesity by age and sex are presented in Table 1. Obesity was significantly greater in boys compared with girls ($P < 0.05$), although there were no significant differences between boys and girls in the prevalence of overweight (Table 1). The prevalence of underweight was higher in girls compared with boys ($P < 0.01$).

Prevalence rates from 2009 to 2013, for boys and girls combined and by sex, are presented in Table 2. Obesity increased significantly in boys and girls ($P < 0.05$). There were no significant changes in overweight or underweight. While not significant, the prevalence of underweight girls increased from 12.0% in 2009 to 16.7% in 2013. The prevalence of underweight boys remained the same, 7.1% in 2009 and 7.3% in 2013.

Prevalence rates of underweight, overweight and obesity according to SES are presented in Table 3. SES was significantly lower in underweight, overweight and obese boys and girls compared with youths of normal weight ($P = 0.003$). During the course of the study, the prevalence of overweight and obesity in boys was higher in low and middle SES compared with high SES ($P < 0.001$). In girls, the prevalence of underweight, overweight and obesity was higher in low and middle SES compared with high SES ($P < 0.001$).

Discussion

Short- and long-term health outcomes associated with underweight, overweight and obesity in children and adolescents are important issues influencing public health policy^(16,22). Therefore, regular monitoring of BMI is recommended to track data and to assess the effectiveness of intervention programmes⁽²³⁾. To date, such tracking of children and adolescents in France has been inconsistent^(17,18,24).

By applying recommended international standards, the results of the present study suggest that combined overweight and obesity did not change significantly in boys and girls between 2009 and 2013, although the prevalence was higher compared with data published previously, 21.5% in 2012 *v.* 15.4% in 2004⁽¹⁷⁾. Differences might be attributed to sampling error because previous data were collected in a specific part of France (i.e. only from two administrative regions⁽¹⁷⁾) while the present study included most of the country (i.e. sixteen of twenty-two administrative regions). Separating obesity from overweight, our findings showed a significant increase in obese children and adolescents in both boys and girls.

Data from the present study also suggest that the prevalence of overweight and obesity is higher in children and adolescents with low SES. These findings are in agreement with previous studies in France^(17,24), Europe^(25–27) and the USA⁽²⁸⁾. Similarly, our data show that

Table 1 Prevalence rates of underweight, overweight and obesity, and mean height, weight and BMI and their standard deviations, in French boys and girls according to age class* during the period 2009–2013 (n 9669); BOUGE Program

	Boys						Girls										
	Childhood		Early adolescence		Late adolescence		Total		Childhood		Early adolescence		Late adolescence		Total		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Underweight																	
Prevalence (%)	7.5		8.9		2.4		8.4		7.5		12.2		17.0		12.1		0.004
Height (cm)	145.60	7.56	150.20	8.92	157.00	8.77	148.77	8.77	144.63	8.79	150.09	8.41	153.73	8.41	150.02	8.46	0.02
Weight (kg)	30.56	3.38	33.82	4.53	35.00	4.46	32.80	4.46	29.65	3.97	33.75	4.47	37.21	4.47	33.74	4.58	0.001
BMI (kg/m ²)	14.38	0.65	14.93	0.75	14.20	0.76	14.76	0.76	14.12	0.55	14.92	0.77	15.70	0.77	14.92	0.81	0.001
Overweight																	
Prevalence (%)	14.7		16.8		21.0		16.2		17.5		15.1		15.0		15.3		0.252
Height (cm)	149.97	8.21	157.40	8.63	171.22	9.31	155.13	9.31	149.84	6.57	154.94	7.73	161.54	7.73	154.76	7.83	0.40
Weight (kg)	50.34	6.74	58.95	7.87	74.08	8.73	56.31	8.73	49.34	5.49	56.69	7.26	67.13	7.26	56.46	7.61	0.72
BMI (kg/m ²)	22.29	1.42	23.70	1.44	25.23	1.29	23.26	1.59	21.93	1.34	23.53	1.52	25.67	1.52	23.47	1.61	0.009
Obese																	
Prevalence (%)	5.0		5.1		4.6		5.0		7.8		3.7		5.2		4.0		0.02
Height (cm)	154.10	7.05	159.46	8.87	176.00	9.90	157.69	8.79	152.24	9.63	155.86	8.69	163.75	8.69	155.72	9.05	0.02
Weight (kg)	65.15	8.85	75.58	11.64	107.60	21.78	72.14	12.29	62.67	8.04	71.89	11.79	91.03	11.79	71.49	12.56	0.58
BMI (kg/m ²)	27.33	2.06	29.61	2.88	34.51	3.14	28.84	2.87	27.07	3.16	29.43	2.91	33.75	2.91	29.30	3.16	0.11

*Childhood: 9–11 years in boys and 9–10 years in girls; early adolescence: 12–14 years in boys and 11–13 years in girls; late adolescence: 15–16 years in boys and 14–16 years in girls.

†The χ^2 test was performed to assess differences in prevalence rates by sex; Student's *t* test was performed to assess differences in anthropometric data by sex. Significant *P* values are indicated in bold font.

Table 2 Prevalence rates of underweight, overweight and obesity, overall and by sex, in French boys and girls from 2009 to 2013 (*n* 9669); BOUGE Program

	2009 (<i>n</i> 1848)		2010 (<i>n</i> 1818)		2011 (<i>n</i> 2578)		2012 (<i>n</i> 2165)		2013 (<i>n</i> 1260)		<i>P</i> for trend*
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
Underweight											
Overall	178	9.6	173	9.5	294	11.4	189	8.7	151	12.0	0.2297
Boys	65	7.1	75	8.5	122	9.4	93	8.4	46	7.3	0.7695
Girls	113	12.0	98	10.5	172	13.5	96	9.1	105	16.7	0.1510
Overweight											
Overall	280	15.2	298	16.4	409	15.9	347	16.0	185	14.7	0.8170
Boys	149	16.4	137	15.6	220	16.9	169	15.3	105	16.6	0.9297
Girls	131	13.9	161	17.2	189	14.8	178	16.8	80	12.7	0.7928
Obese											
Overall	70	3.8	75	4.1	94	3.7	120	5.5	77	6.1	0.0003
Boys	37	4.1	36	4.1	59	4.5	72	6.5	38	6.0	0.0056
Girls	33	3.5	39	4.2	35	2.8	48	4.5	39	6.2	0.0209

*Cochran–Armitage trend test. Significant *P* values are indicated in bold font.

Table 3 Mean socio-economic status scores and their standard deviations, and prevalence rates of low, medium and high socio-economic status*, according to weight category, in French boys and girls during the period 2009–2013 (*n* 9669); BOUGE Program

	Score			Low		Medium		High		<i>P</i> ‡
	Mean	SD	<i>P</i> †	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
Boys										
Underweight	0.743	0.040	0.0001	47	11.72	275	68.58	79	19.70	<0.001
Normal weight	0.744	0.041		306	8.97	2187	64.10	919	26.93	<0.001
Overweight	0.741	0.043		214	27.16	471	59.77	103	13.07	<0.001
Obese	0.733	0.045		90	37.19	127	52.48	25	10.33	<0.001
Girls										
Underweight	0.741	0.042	0.0023	109	18.66	408	69.86	67	11.47	<0.001
Normal weight	0.744	0.042		462	13.92	2086	62.87	770	23.21	<0.001
Overweight	0.741	0.041		177	23.95	482	65.22	80	10.83	<0.001
Obese	0.732	0.042		54	27.84	121	62.37	19	9.79	<0.001

*Socio-economic status is based on the Human Development Index (HDI), collected using the zip code of the school. A higher HDI score is achieved when the life expectancy at birth is longer, the education period is longer and the income per capita is higher.

†ANOVA was used to compare the score of socio-economic status among different BMI categories. Significant *P* values are indicated in bold font.

‡ANOVA was used to compare the prevalence rates of the socio-economic status categories among different BMI categories. Significant *P* values are indicated in bold font.

low SES is also associated with underweight children and adolescents. Interestingly, the phenomenon of overweight and obesity may coexist with underweight in the same population⁽²⁹⁾.

Low body fat and lean mass, typical of underweight children and adolescents, is associated with poor quality of life, lower physical fitness, amenorrhea, decreased bone mineral content, negative body image and fatigue^(12–15), and increased mortality as adults⁽¹⁶⁾, when compared with adolescents and children of normal weight. Our findings show that the prevalence of underweight French girls increased by 39% between 2009 and 2013, from 12.0 to 16.7%, although the change was not significant. This result may be due to the analysis strategy. Using the Cochran–Armitage trend test, we examined linearity changes and not the differences between each year. Nevertheless, the high prevalence of underweight in young girls suggests a need for health intervention to address this problem. Increased prevalence of

underweight from 2009 to 2013 might also be the result of increased numbers of children and adolescents who arrived from other countries and entered into the French school system, especially from Africa. For a variety of reasons the anthropometric measures of these children and adolescents may differ from those of European children. However, according to regulatory rules in clinical research, we cannot collect any information about the ethnic diversity.

One of the strengths of the present study was the large sample size representing most of France. The large sample size provided investigators an opportunity to assess underweight, overweight and obesity according to age, sex and SES. Standardized testing and data collection was another strength. A potential weakness is that subjects volunteered and were not selected at random. Even though we collected data on a large sample in many administrative regions (sixteen out of twenty-two regions), the study did not use a stratified sample design. Therefore,

we cannot establish that this cohort is fully representative of French children and adolescents. The severe economic downturn in France between 2009 and 2013 could have had an impact on our findings as a consequence of changes in living habits at another time point. As a consequence, the authors recommend studies that incorporate random subject selection.

In summary, data from the present study suggest that obesity increased in French youth between 2009 and 2013, and occurred more frequently in boys and girls of low SES. The prevalence of overweight was high but did not change over the course of the study. Our results also indicate that underweight increased substantially in girls. Although the differences were not significant, they warrant careful monitoring. Based on the study findings, the authors support public health initiatives in French children and adolescents to prevent and treat unhealthy weight issues in this population.

Acknowledgements

Acknowledgements: The authors thank all participating youths and teachers for their collaboration in the study.

Financial support: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Conflict of interest: The authors declared no conflict of interest. *Authorship:* Each author of this article contributed significantly to the study. J.V., J.-B.B., J.M. and Z.U. designed the research; J.V., J.-B.B., P.S.F., L.B., J.M. and Z.U. conducted the research; J.V. and J.-B.B. analysed the data; J.-B.B. and J.V. performed the statistical analysis; J.V., J.-B.B., P.S.F. and L.B. wrote the paper; Z.U. had primary responsibility for the final content; all authors read and approved the final manuscript. *Ethics of human subject participation:* This study was conducted according to the guidelines laid down in the Declaration of Helsinki and the European Good Clinical Practices. The study was approved as an epidemiological study by the CPP Nord-Ouest IV (Lille, France) research ethics committee. In this context, written informed consent was not required according to French human research regulations. Data collection was approved by the French National Commission of the Informatics Personal Data (Commission Nationale Informatique et Liberté).

References

- Ogden CL, Yanovski SZ, Carroll MD *et al.* (2007) The epidemiology of obesity. *Gastroenterology* **132**, 2087–2102.
- Olds T, Maher C, Zumin S *et al.* (2011) Evidence that the prevalence of childhood overweight is plateauing: data from nine countries. *Int J Pediatr Obes* **6**, 342–360.
- Schmidt Morgen C, Rokholm B, Sjöberg Brixval C *et al.* (2013) Trends in prevalence of overweight and obesity in Danish infants, children and adolescents – are we still on a plateau? *PLoS One* **24**, e69860.
- Castetbon K (2015) Recent prevalence of child and adolescent overweight and obesity in France and abroad. *Arch Pediatr* **22**, 111–115.
- Martin K, Rosenberg M, Pratt IS *et al.* (2014) Prevalence of overweight, obesity and underweight in Western Australian school-aged children; 2008 compared with 2003. *Public Health Nutr* **17**, 2687–2691.
- Martinez-Vizcaino V, Sanchez Lopez M, Moya Martinez P *et al.* (2009) Trends in excess weight and thinness among Spanish schoolchildren in the period 1992–2004: the Cuenca study. *Public Health Nutr* **12**, 1015–1018.
- 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.
- Reilly JJ, Methven E, McDowell ZC *et al.* (2003) Health consequences of obesity. *Arch Dis Child* **88**, 748–752.
- Ringbäck Weitoft G, Eliasson M & Rosén M (2008) Underweight, overweight and obesity as risk factors for mortality and hospitalization. *Scand J Public Health* **36**, 169–176.
- Jee SH, Sull JW, Park J *et al.* (2006) Body-mass index and mortality in Korean men and women. *N Engl J Med* **355**, 779–787.
- Klenk J, Nagel G, Ulmer H *et al.* (2009) Body mass index and mortality: results of a cohort of 184,697 adults in Austria. *Eur J Epidemiol* **24**, 83–91.
- Stokic E, Srdic B & Barak O (2005) Body mass index, body fat mass and the occurrence of amenorrhea in ballet dancers. *Gynecol Endocrinol* **20**, 195–199.
- Vicente-Rodriguez G, Urzanqui A, Mesana MI *et al.* (2008) Physical fitness effect on bone mass is mediated by the independent association between lean mass and bone mass through adolescence: a cross-sectional study. *J Bone Miner Metab* **26**, 288–294.
- Sato H, Nakamura N & Sasaki N (2008) Effects of bodyweight on health-related quality of life in school-aged children and adolescents. *Pediatr Int* **50**, 552–556.
- Mak KK, Ho SY, Lo WS *et al.* (2010) Health-related physical fitness and weight status in Hong Kong adolescents. *BMC Public Health* **23**, 88.
- Flegal KM, Graubard BI, Williamson DF *et al.* (2007) Cause-specific excess deaths associated with underweight, overweight, and obesity. *JAMA* **298**, 2028–2037.
- Péneau 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.
- Lazzeri G, Rossi S, Kelly C *et al.* (2014) Trends in thinness prevalence among adolescents in ten European countries and the USA (1998–2006): a cross-sectional survey. *Public Health Nutr* **17**, 2207–2215.
- Pietrobelli A, Faith MS, Allison DB *et al.* (1998) Body mass index as a measure of adiposity among children and adolescents: a validation study. *J Pediatr* **132**, 204–210.
- Cole TJ, Bellizzi MC, Flegal KM *et al.* (2000) Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* **320**, 1240–1243.
- Cole TJ, Flegal KM, Nicholls D *et al.* (2007) Body mass index cut offs to define thinness in children and adolescents: international survey. *BMJ* **335**, 194.
- Lobstein T, Baur L & Uauy R (2004) Obesity in children and young people: a crisis in public health. *Obes Rev* **5**, Suppl. 1, 4–104.
- Nutbeam D (1998) Evaluating health promotion – progress, problems and solutions. *Health Promot Int* **13**, 27–44.
- Klein Plata C, Wagner A, Haan MC *et al.* (2003) Prevalence and sociodemographic determinants of overweight in young French adolescents. *Diabetes Metab Res Rev* **19**, 153–158.

25. Gnavi R, Spagnoli TD, Galotto C *et al.* (2000) Socioeconomic status, overweight and obesity in pre-pubertal children: a study in an area of Northern Italy. *Eur J Epidemiol* **16**, 797–803.
26. Fredriks AM, van Buuren S, Witt JM *et al.* (2000) Body index measurements in 1996–7 compared with 1980. *Arch Dis Child* **82**, 107–112.
27. Kromeyer-Hauschild K, Zellner K, Jaeger U *et al.* (1999) Prevalence of overweight and obesity among school children in Jena (Germany). *Int J Obes Relat Metab Disord* **23**, 1143–1150.
28. Kimm SYS, Obarzanek E, Barton BA *et al.* (1996) Race socioeconomic status and obesity in 9- to 10-year-old girls: the NHLBI growth and health study. *Ann Epidemiol* **6**, 266–275.
29. Doak CM, Adair LS, Bentley M *et al.* (2005) The dual burden household and the nutrition transition paradox. *Int J Obes (Lond)* **29**, 129–136.