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

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Jérémy Vanhelst, Jean-Benoît Baudelet, Paul S Fardy, Laurent Béghin, Jacques Mikulovic, Zékya Ulmer5

1 **ABSTRACT**

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4 **Objectives:** To determine the prevalence of underweight, overweight and obesity in French youth

5 from 2009 to 2013 and to determine if there are differences in weight categories according to

6 socioeconomic status.

7 **Design:** Cross-sectional study performed in different regions of France. Physical measures included

8 weight, height and body mass index. Underweight, overweight and obesity were defined according

9 to age- and gender-specific BMI cut-off points from the International Obesity Taskforce.

10 **Setting:** France

11 **Subjects:** 9 670 children and adolescents (4836 Boys, 4834 girls) from in the French national

12 BOUGE program between 2009 and 2013.

13 **Results:** The prevalence of obesity was higher in boys than girls (p<0.05). In contrast, underweight

14 was more prevalent in girls (p < 0.05). Although there were no significant changes in overweight or

15 underweight boys or girls from 2009 to 2013, there was a significant increase in obesity in boys and

16 girls (p < 0.05) during the same time period. The prevalence of underweight increased in girls from

17 12 to 16.7% (p>0.05) and remained unchanged in boys (7.1%-7.3%) between 2009 and 2013.

18 Overweight and obesity were higher in low socioeconomic families (p < 0.0001).

19 **Conclusions:** Findings suggest that prevalence of overweight was stable although high in French

20 children and adolescents while the prevalence of obesity increased significantly. Changes in

21 underweight, although not significant, were high in girls and merit further attention. Improving

22 public health interventions, especially in high-risk low socio-economic populations, may help to

23 modify the behavior that contributes to underweight, overweight and obesity in young boys and

24 girls.

25

26 **Keywords:** prevalence; obesity; underweight, youth, public health

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1   Introduction

2   Overweight and obesity are associated with increased body fat, a consequence of positive

3   energy balance over a prolonged period of time, i.e. energy intake exceeds energy expenditure[1].

4   Recent studies suggest that the prevalence of overweight and obesity is high, although stable, in

5   children and adolescents [2-4]. The prevalence of underweight, however, is high and continues to

6   increase[5-7]. Overweight and obesity in youth are associated with type 2 diabetes, metabolic

7   syndrome, poor quality of life, lower physical fitness and self esteem, and, in later life, with

8   increased risk of coronary heart disease and cancer[8-11]. Underweight in children and adolescents is

9   associated with a poor quality of life, lower physical fitness, amenorrhea, decreased bone mineral

10   content, negative body image and fatigue, and, in later life, increased mortality[12-16].

11   Monitoring underweight, overweight and obesity in children and adolescents is essential for

12   accurate tracking and to evaluate effectiveness of public health recommendations and intervention

13   programs**.** Studies of French children and adolescents found that overweight and obesity were stable

14   between 1996 and 2006, although data were limited to Central and Western France[17]. To our

15   knowledge, obesity and overweight have not been updated in France since 2009. Furthermore, few

16   data are available on the prevalence of underweight in French children and adolescents[18]. Previous

17   studies reported a prevalence of underweight of 7% and 15% in French boys and girls, respectively,

18   in 2006[18].

19   The purpose of the present study was to measure the prevalence of underweight, overweight

20   and obesity in French children and adolescents from 2009 to 2013, to compare test scores with

21   findings prior to 2009 and to measure differences in weight categories according to socioeconomic

22   status.

23

24   Methods

25   *Study design*

26   Data for the study are from the French health promotion campaign "Move, a priority for your

27   health" (http://www.bougetasante.fr/), the BOUGE Program. The objectives of BOUGE were: 1) to

28   assess physical fitness of children and adolescents, and, 2) to promote the benefits of physical

29   activity and physical fitness on the health of youth, ages 9 to 16 years in French schools

30   (http://www.bougetasante.fr/). The program was developed by a French health care organisation

31   (Fédération Nationale Mutualité Française; http://www.mutualite.fr) and the National School Sport

32   Union (Union Nationale du Sport Scolaire; unss.org) and consisted of two days during the school

33   year; one day to assess physical fitness (including anthropometric characteristics) and the second

34   day to promote the health benefits of physical activity. Children and adolescents participating in the

35   BOUGE Program were assessed only one time during the study. Each year a different group of

1 students was measured. The study was approved by the Research Ethical Committee (CPP Nord-

2 Ouest IV, Lille, France). All procedures were performed in accordance with the Helsinki

3 Declaration of 1975 as revised in 2008, and the European Good Clinical Practices. As the study did

4 not involve an intervention and data were collected retrospectively by the study organizational

5 structure (http://www.mutualite.fr/), the study was approved by a Research Ethical Committee (CPP

6 Nord-Ouest IV, Lille, France) as an epidemiological study. In this context, written informed consent

7 was not required according to French human research regulations. Data collection was approved by

8 the French National Commission of the Informatics Personal Data (Commission Nationale

9 Informatique et Liberté).

10   A manual of operations was developed for teachers and participants in order to standardize test

11 procedures (http://eps-bergpfad.fr/Sante_Bouge_Sommaire.html). Included in the manual were:

12 rationale of the study, test procedures, and how data were collected. Teachers recorded test results

13 into an electronic data system provided by the trial sponsor. An audit of the complete data set was

14 performed and the aberrant data were excluded.

15   Data were collected in 16 regions of France in 101 schools. All schools in France were invited

16 to participate in the study. Each school director decided whether or not to participate. If the school

17 agreed to participate, the students, between 9 and 16 years were invited to participate. In total,

18 12082 adolescents, 6107 girls and 5975 boys volunteered to participate. Of this number, 9 670 were

19 included in the present study. Two thousand four hundred twelve were excluded because of missing

20 or incomplete.

21

22 Measurements

23 Anthropometric Measures

24   Weight and height, respectively, were measured in shorts and T-shirts without shoes to the

25 nearest 0.1 kg using an electronic scale and the nearest 0.1 cm using a standard physician's scale in

26 a private room. Body mass index (BMI), a valid estimate of body fatness in children and

27 adolescents[20], was calculated from weight (kg) divided by height (m²). Underweight, overweight

28 and obese was assessed using international age- and gender-specific cut-off points[21-22].

29

30 Socioeconomic status (SES)

31   The Human Development Index (HDI), developed by the United Nations Development

32 Program (http://hdr.undp.org/en), was used to assess SES of the family living in a city. The HDI

33 considers the following factors: (*i*) a long and healthy life: life expectancy at birth; (*ii*) education

34 index: mean years of schooling and expected years of schooling; and (*iii*) standard of living: gross

35 income per capita. A city scores higher HDI when the life expectancy at birth is longer, the

1 education period is longer, and the income per capita is higher. The HDI score was collected using

2 zip code of the school (www.insee.fr).

3

4 *Statistical analysis*

5   Data are presented as percentages for qualitative and mean ± standard deviation (SD) for

6 quantitative variables. Normality of distribution was checked graphically and by using the Shapiro–

7 Wilk test.

8   Comparisons of underweight, overweight and obesity between boys and girls were assessed by

9 Chi square. Changes in underweight, overweight and obesity from 2009 to 2013 were assessed

10 using the Cochran-Armitage trend test. Analysis of variance (ANOVA) was used to compare SES

11 among different BMI categories (underweight, overweight and obesity).

12   All statistical tests were performed at the 2-tailed α level of 0.05. Data were analyzed using the

13 Statistical Package for the Social Sciences, Windows 22 (SPSS Inc., Chicago, IL, USA), Excel

14 2010 (Microsoft Inc., Redmond, WA, USA).

15

16 **Results**

17   Mean heights, weights, BMIs and prevalence rates of underweight, overweight and obesity by

18 age and gender are presented in Table 1. Obesity was significantly greater in boys compared to girls

19 ($p < 0.05$), although there were no significant differences between boys and girls in the prevalence

20 of overweight (Table 1). The prevalence of underweight was higher in girls compared to boys ($p <$

21 0.01).

22   Prevalence rates from 2009 to 2013, gender-specific and combined boys and girls, are

23 presented in Table 2. Obesity increased significantly in boys and girls. There were no significant

24 changes in overweight or underweight. While not significant, prevalence of underweight girls

25 increased from 12% in 2009 to 16.7% in 2013. The prevalence of underweight boys remained the

26 same, 7.1% in 2009 and 7.3% in 2013.

27   Prevalence rates of underweight, overweight and obesity according to SES are presented in

28 Table 3. Socioeconomic status was significantly lower in underweight, overweight and obese boys

29 and girls compared to youth of normal weight ($p < 0.003$). During the course of the study,

30 prevalence of overweight and obesity in boys was higher in low and middle SES compared to high

31 SES ($p < 0.001$). In girls, the prevalence of underweight, overweight and obesity was higher in low

32 and middle SES compared to high SES ($p < 0.001$).

33

34 **Discussion**

4

Short- and long-term health outcomes associated with underweight, overweight and obesity in children and adolescents are important issues influencing public health policy[16, 23]. Therefore, regular monitoring of body mass index is recommended to track data and to assess effectiveness of intervention programs[24]. To date, such tracking of children and adolescents in France has been inconsistent[17-18, 25].

By applying recommended international standards, 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 to 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. 16 of 22 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 socioeconomic status. These findings are in agreement with previous studies in France[17, 25], Europe[26-28] and the United States[29]. Similarly, our data show that low socioeconomic status is also associated with underweight children and adolescents. Interestingly, the phenomenon of overweight and obesity may coexist with underweight in the same population [30].

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 when compared with adolescents and children of normal weight[16]. Our findings show that the prevalence of underweight French girls increased 39% between 2009 and 2013, from 12 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 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, gender and socioeconomic status. Standardized testing and data collection

was another strength. A potential weakness is that subjects volunteered and were not selected at random. Even if we collected data on a large sample in many administrative regions (16 out of 22 regions), this 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 down turn in France, between 2009 to 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 socioeconomic status. 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 to treat unhealthy weight issues in this population.

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Table 1. Mean of prevalence rates in boys and girls according to age class during the period 2009-2013 (n = 9 669)

	Boys				Girls				
	Childhood[†]	Early adolescence	Late adolescence	Total	Childhood	Early adolescence	Late adolescence	Total	P*
Underweight									
Prevalence (%)	7.5	8.9	2.4	8.4	7.5	12.2	17	12.1	**0.004**
Height (*cm*)	145.6 ± 7.56	150.2 ± 8.92	157 ± 0.0	148.77 ± 8.77	144.63 ± 8.79	150.09 ± 8.41	153.73 ± 6.76	150.02 ± 8.46	**0.02**
Weight (*kg*)	30.56 ± 3.38	33.82 ± 4.53	35.00 ± 0.0	32.8 ± 4.46	29.65 ± 3.97	33.75 ± 4.47	37.21 ± 4.58	33.74 ± 4.58	**0.001**
BMI ($kg.m^2$)	14.38 ± 0.65	14.93 ± 0.75	14.2 ± 0.0	14.76 ± 0.76	14.12 ± 0.55	14.92 ± 0.77	15.7 ± 1.09	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 ± 6.1	155.13 ± 9.31	149.84 ± 6.57	154.94 ± 7.73	161.54 ± 6.76	154.76 ± 7.83	0.40
Weight (*kg*)	50.34 ± 6.74	58.95 ± 7.87	74.08 ± 7.12	56.31 ± 8.73	49.34 ± 5.49	56.69 ± 7.26	67.13 ± 6.53	56.46 ± 7.61	0.72
BMI ($kg.m^2$)	22.29 ± 1.42	23.7 ± 1.44	25.23 ± 1.29	23.26 ± 1.59	21.93 ± 1.34	23.53 ± 1.52	25.67 ± 1.34	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*)	154.1 ± 7.05	159.46 ± 8.87	176.0 ± 9.90	157.69 ± 8.79	152.24 ± 9.63	155.86 ± 8.69	163.75 ± 9.72	155.72 ± 9.05	**0.02**
Weight (*kg*)	65.15 ± 8.85	75.58 ± 11.64	107.6 ± 21.78	72.14 ± 12.29	62.67 ± 8.04	71.89 ± 11.79	91.03 ± 15.14	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 ± 3.3	29.3 ± 3.16	0.11

1 * Chi Square test was performed to assess difference for prevalence rates between sex; Student test was performed to asses differences for anthropometric data between sex.

2 [†] (*i*) Childhood: 9-11 years in boys and 9–10 years in girls; (*ii*) early adolescence: 12–14 years in boys and 11–13 years in girls; (*iii*) late adolescence: 15-16 years in boys and 14–16 years in girls

1

Table 2. Prevalence rates (overall and gender-specific) from 2009 to 2013

		2009		2010		2011		2012		2013		P for Trend*
		n (1848)	%	n (1818)	%	n (2578)	%	n (2165)	%	n (1260)	%	
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	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	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	**0.0056**
	Girls	33	3.5	39	4.2	35	2.8	48	4.5	39	6.2	**0.0209**

* Coc2hran-Armitage trend test

1

2

Table 3. Mean values (SD) and prevalence rates of the socioeconomic status (HDI)[§] according to weight categories

	Score Mean (SD)	P*		Low n	%	Medium n	%	High n	%	P**
Boys										
Underweight	0.743 (0.040)			47	11.72	275	68.58	79	19.7	**<0.001**
Normal Weight	0.744 (0.041)	**0.0001**		306	8.97	2187	64.1	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)			109	18.66	408	69.86	67	11.47	**<0.001**
Normal Weight	0.744 (0.042)	**0.0023**		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**

3 [§] HDI : Human Index Development. A higher HDI is when the life expectancy at birth is longer, the education period is
4 longer, and the income per capita is higher
5 * Anova analysis was used to compare the score of the socioeconomic status among different BMI categories
6 ** Anova analysis was used to compare the prevalence rates of the socioeconomic status among different BMI categories