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Short Communication

Trends in the prevalence of overweight, obesity and underweight in French children, aged 4–12 years, from 2013 to 2017

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Abstract

Objective: To assess the prevalence of underweight, overweight and obesity in French children from 2013 to 2017.

Design: Cross-sectional study performed in fourteen 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 (10 159 boys, 9757 girls) from the voluntary, non-representative Diagnoform programme between 2013 and 2017, at the age of 4–12 years.

Results: The prevalence of overweight and obesity was higher in girls compared with boys ($P < 0{\cdot}001$). Underweight was also more prevalent in girls ($P < 0{\cdot}05$). Although there were no significant changes in the prevalence of obesity in boys or girls from 2013 to 2017, a significant decrease in overweight among boys and girls was found ($P < 0{\cdot}001$) during the same time period. In contrast, the prevalence of underweight increased in girls and boys (from 10·0 to 20·0 %, $P < 0{\cdot}0001$) between 2013 and 2017.

Conclusions: Results of the current study show that the prevalence of obesity was stable, while the prevalence of overweight decreased significantly, despite high in French children. Findings suggest also that thinness is becoming an important phenomenon in children. Developing preventive and nutritional programmes in order to modify the lifestyle might help control underweight and obesity in children.

Keywords
Prevalence
Obesity
Overweight
Underweight
France

Overweight and obesity are pathologies marked by an increase in body fat as a consequence of a positive energy balance, when the energy intake exceeds energy expenditure over a prolonged period. Obesity in children is considered the main childhood health problem in European countries. In 2010, based on the International Obesity Task Force (IOTF) definitions and the WHO's Childhood Obesity Surveillance Initiative, it was estimated that about 25 % of European children (aged 6–9 years) were overweight or obese[1]. A recent systematic review and meta-analysis observed a high prevalence of childhood overweight and obesity with a trend for stabilisation in most European countries[2]. Paediatric obesity and related consequences on physical, social and psychological parameters have been widely demonstrated[3]. In addition, the persistence of paediatric obesity into adulthood can lead to increased morbidity from type 2 diabetes, CVD and cancer, and increased early mortality[4]. While the prevalence of overweight and obesity has been studied broadly, data on the prevalence of underweight are scarce and limited. Nevertheless, some studies

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suggest that the prevalence of underweight tends to increase in developed countries[5–7]. Underweight in children is also linked to many serious physical, psychological and social consequences on health from childhood to adulthood[8,9].

Monitoring the weight status in children across different countries is essential and may help identify the target population for primary prevention and health promotion policies. To date, tracking of children about their weight status (underweight, overweight and obesity) in France has been inconsistent, and data are missing since 2010[1,2].

The purpose of the current study was first to measure the prevalence of underweight, overweight and obesity in French children from 2013 to 2017 and to compare the results with findings prior to 2013.

Methods

This ancillary study used data from the French health programme 'Diagnoform®' (https://irfo.fr/). The principal objective of this programme was to assess the physical fitness of a large, voluntary, non-representative sample of the French population aged 5–60 years and older. This programme was divided into four categories: (i) DiagnoKid for children aged 4–10 years; (ii) DiagnoTonic for adolescents and young adults aged 10–25 years; (iii) DiagnoActif for adults aged 25–60 years; and (iv) DiagnoHealth for people aged ≥60 years. The programme was performed in large settings throughout France, such as school playgrounds or sports club gymnasiums.

All procedures were performed in accordance with the 1975 Helsinki Declaration as revised in 2008 and the European Good Clinical Practices. As the research did not involve an intervention and the data were collected retrospectively using the organisational structure of the study (Institut des Rencontres de la Forme; https://irfo.fr/), the current study was considered an epidemiological study. In this context, written informed consent was not required according to French human research regulations. All data obtained from the organiser (results of physical fitness tests and anthropometrics data) of the event were anonymous, declared and approved by the French National Commission of the Informatics Personal Data (Commission Nationale de l'Informatique et des Libertés). The aims and objectives of the Diagnoform programme were explained carefully to each child and to their parents. After this explanation, the children and parents could either accept or decline to participate in this event and to allow their data to be recorded anonymously. The data were recorded into an electronic data system by the organiser. For the current study, data analyses were performed using only children's data.

Many schools in France were invited to participate in the study, with each school director deciding whether to participate or not. From the 356 schools invited, 309 have accepted to participate in the Diagnoform programme (i.e. 85 % of positive response). When the director accepted the invitation, all students were invited to participate. However, due to sick or absent children on the day of assessment, 11 % of students (3534) could not participate. Each year, a different group of students was measured. In addition, data were collected from fourteen of the twenty-two regions of France (i.e. 64 %). From the Diagnoform programme performed between 2010 and 2018 with an age range of 4–17 years, 32 132 (16 378 boys and 15 754 girls) volunteered to participate. Because of the small sample size of participants aged 13–17 years compared with other age–sex classes and the data obtained from 2010–2012 and 2018, we restricted the analysis to 19 916 (10 159 boys and 9757 girls) children and adolescents aged 4–12 years.

Measurements

Anthropometric measures

Body weight was measured to the nearest 0·1 kg using an electronic scale with the participant wearing light clothes and without shoes. Height was measured without shoes to the nearest 0·1 cm using a standard physician's scale. BMI was calculated as weight/height-squared (kg/m^2). Nutritional status was assessed using the IOTF scale[10].

Statistical analysis

Data are presented as percentages for categorical variables and as means and SD for continuous variables. The normality of distribution was checked graphically 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 2013 to 2017 were assessed using the Cochran–Armitage trend test.

All statistical tests were performed at a two-tailed α level of 0·05. Data were analysed using the statistical software packages IBM SPSS Statistics for Windows (version 22.0; IBM SPSS), R Project for Statistical Computing (version 3.6.1) and Excel 2013 (Microsoft).

Results

The mean age of boys and girls was 8·7 ± 1·6 and 8·6 ± 1·6 years, respectively. Mean height, weight, BMI and prevalence rates of underweight, overweight and obesity by sex and age group are presented in Table 1. Overweight and obesity were significantly greater in girls compared with boys ($P < 0·001$) (Table 1). The prevalence of underweight was also higher in girls than boys ($P < 0·01$).

The prevalence rates from 2013 to 2017 for boys and girls combined and by sex are presented in Table 2 and Fig. 1. No significant changes in obesity were found for boys and girls, respectively ($P > 0·05$) (Table 2). The proportion of overweight was lower in 2017 than in 2013

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Table 1 Prevalence rates of underweight, overweight and obesity, and mean anthropometric characteristics with SD in French boys and girls aged 4–12 years for the period 2013–2017 (*n* 19 916)

	Boys								Girls								
	4–6 years		7–9 years		10–12 years		Total		4–6 years		7–9 years		10–12 years		Total		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*P**
Underweight																	
Prevalence																	**<0·05**
n	212		746		280		1238		191		717		333		1241		
%	17·12		60·26		22·62		12·19		15·39		57·78		26·83		12·72		
Height (cm)	120·21	5·93	129·68	7·81	138·24	9·02	129·4	9·89	118·66	5·43	127·68	7·65	138·79	8·93	129·36	10·27	**0·913**
Weight (kg)	22·84	2·60	27·14	4·07	27·11	3·91	22·90	4·10	18·40	1·76	21·76	3·02	27·17	4·05	22·72	4·36	**0·202**
BMI (kg/m^2)	15·60	0·97	16·08	1·18	14·11	0·64	13·57	0·72	13·05	0·56	13·29	0·65	14·03	0·81	13·45	0·76	**<0·001**
Overweight																	
Prevalence																	**<0·001**
n	160		838		443		1441		190		918		478		1586		
%	11·10		58·15		30·74		14·18		11·98		57·88		30·14		16·25		
Height (cm)	123·36	6·7	133·12	35·40	146·41	6·76	135·25	10·47	122·60	6·07	132·18	7·77	147·09	7·93	134·54	11·15	**<0·01**
Weight (kg)	28·45	3·35	35·40	5·46	47·74	5·64	37·75	8·23	27·92	3·20	34·86	5·40	48·34	22·25	37·31	8·74	0·73
BMI (kg/m^2)	18·63	0·67	19·85	1·12	22·21	1·35	20·35	1·65	18·52	0·69	19·82	1·19	22·25	1·34	20·28	1·70	0·166
Obese																	
Prevalence																	**<0·001**
n	65		314		174		553		91		360		151		602		
%	11·75		56·78		31·46		5·44		15·12		59·80		25·08		6·17		
Height (cm)	124·29	6·01	134·27	8·52	148·64	8·51	136·28	10·97	122·87	6·04	132·51	7·89	148·70	8·03	134·53	11·20	**<0·001**
Weight (kg)	34·46	4·46	44·43	8·74	61·60	9·81	47·16	12·01	34·40	5·83	42·23	7·75	61·45	10·43	45·19	12·14	**<0·001**
BMI (kg/m^2)	22·26	1·95	24·45	2·79	27·75	2·67	24·97	3·19	22·71	3·11	23·88	2·56	27·64	2·98	24·51	3·19	**<0·01**
Normal weight																	
Prevalence																	**<0·001**
n	916		4267		1744		6927		901		3891		1536		6328		
%	13·22		61·60		25·18		68·16		14·24		61·49		24·27		64·85		
Height (cm)	120·86	5·37	129·60	7·17	142·64	7·35	131·74	9·82	119·60	5·25	128·95	7·69	143·53	7·78	131·18	10·64	**<0·01**
Weight (kg)	23·25	4·64	28·49	6·82	35·27	5·17	28·61	5·87	22·13	2·57	26·82	4·36	35·90	5·51	28·36	6·37	**<0·05**
BMI (kg/m^2)	16·00	2·41	16·78	2·80	17·26	1·49	16·31	1·36	15·43	1·02	16·03	1·23	17·34	1·53	16·26	1·44	**<0·05**

Percentages are row percentages for prevalence rates by age group; percentages are column percentages for total prevalence rates by sex.
*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.

Table 2 Overall and sex-specific number, proportions (%) of children aged 4–12 years classified as underweight, healthy weight, overweight and obese in 2013 and 2017 from the Diagnoform programme

	2013 (*n* 7211)		2014 (*n* 3540)		2015 (*n* 2937)		2016 (*n* 4256)		2017 (*n* 1972)		
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	P_{trend}*
4–6 years											
Underweight											
Overall	69	13·64	39	13·36	52	15·62	226	15·86	17	10	0·5294
Boys	38	15·32	15	10·07	32	19·28	117	16·39	10	13·16	0·4994
Girls	31	12·02	24	16·78	20	11·98	109	15·33	7	7·45	0·8283
Healthy weight											
Overall	344	67·98	195	66·78	230	69·07	931	65·33	117	68·82	0·4148
Boys	167	67·34	99	66·44	113	68·07	481	67·37	56	73·68	0·6266
Girls	177	68·60	96	67·13	117	70·06	450	63·29	61	64·89	0·1108
Overweight											
Overall	66	13·04	43	14·73	39	11·71	176	12·35	26	15·29	0·7809
Boys	34	13·71	27	18·12	18	10·84	73	10·22	8	10·53	**0·0307**
Girls	32	12·40	16	11·19	21	12·57	103	14·49	18	19·15	0·1111
Obese											
Overall	27	5·34	15	5·14	12	3·60	92	6·46	10	5·88	**0·2731**
Boys	9	3·63	8	5·37	3	1·81	43	6·02	2	2·63	**0·2931**
Girls	18	6·98	7	4·90	9	5·39	49	6·89	8	8·51	**0·5933**
7–9 years											
Underweight											
Overall	456	10·46	215	9·40	283	13·97	315	14·51	194	16·10	**<0·0001**
Boys	238	10·92	109	9·11	146	14·05	144	12·70	109	17·67	**<0·0001**
Girls	218	9·99	106	9·71	137	13·88	171	16·49	85	14·46	**<0·0001**
Healthy weight											
Overall	2910	66·73	1588	69·41	1405	69·35	1447	66·65	808	67·05	0·9297
Boys	1483	68·06	838	70·07	734	70·64	803	70·81	409	66·29	0·66
Girls	1427	65·40	750	68·68	671	67·98	644	62·10	399	67·86	0·7065
Overweight											
Overall	719	16·49	353	15·43	259	12·78	274	12·62	151	12·53	**<0·0001**
Boys	339	15·56	174	14·55	118	11·36	133	11·73	74	11·99	**<0·001**
Girls	380	17·42	179	16·39	141	14·29	141	13·60	77	13·10	**<0·001**
Obese											
Overall	276	6·33	132	5·77	79	3·90	135	6·22	52	4·32	**0·0153**
Boys	119	5·46	75	6·27	41	3·95	54	4·76	25	4·05	0·0510
Girls	157	7·20	57	5·22	38	3·85	81	7·81	27	4·59	0·1466
10–12 years											
Underweight											
Overall	227	9·68	102	10·63	76	13·15	58	8·79	150	25·13	**<0·0001**
Boys	112	8·99	43	8·74	30	11·11	25	7·42	70	23·65	**<0·0001**
Girls	115	10·47	59	12·61	46	14·94	33	10·22	80	26·58	**<0·0001**
Healthy weight											
Overall	1519	64·80	612	63·75	377	65·22	430	65·15	342	57·29	**0·0209**
Boys	825	66·21	328	66·67	181	67·04	236	70·03	174	58·78	0·2866
Girls	694	63·21	284	60·68	196	63·64	194	60·06	168	55·81	**0·0387**
Overweight											
Overall	442	18·86	181	18·85	92	15·92	121	18·33	85	14·24	0·0170
Boys	231	18·54	89	18·09	37	13·70	44	13·06	42	14·19	**0·0044**
Girls	211	19·22	92	19·66	55	17·86	77	23·84	43	14·29	0·5122
Obese											
Overall	156	6·66	65	6·77	33	5·71	51	7·73	20	3·35	**0·0661**
Boys	78	6·26	32	6·50	22	8·15	32	9·50	10	3·38	**09763**
Girls	78	7·10	33	7·05	11	3·57	19	5·88	10	3·32	**0·0088**
Total											
Underweight											
Overall	752	10·43	356	10·06	411	13·99	599	14·07	361	18·31	**<0·0001**
Boys	388	10·56	167	9·09	208	14·10	286	13·09	189	19·11	**<0·0001**
Girls	364	10·29	189	11·10	203	13·89	313	15·11	172	17·50	**<0·0001**
Healthy weight											
Overall	4773	66·19	2395	67·66	2012	68·51	2808	65·98	1267	64·25	**0·238**
Boys	2475	67·38	1265	68·86	1028	69·69	1520	69·57	639	64·61	0·9895
Girls	2298	64·95	1130	66·35	984	67·31	1288	62·19	628	63·89	0·1031
Overweight											
Overall	1227	17·02	577	16·30	390	13·28	571	13·42	262	13·29	**<0·0001**
Boys	604	16·44	290	15·79	173	11·73	250	11·44	124	12·54	**<0·0001**
Girls	623	17·61	287	16·85	217	14·84	321	15·50	138	14·04	**0·0012**
Obese											
Overall	459	6·37	212	5·99	124	4·22	278	6·53	82	4·16	0·1507
Boys	206	5·61	115	6·26	66	4·47	129	5·90	37	3·74	0·2738
Girls	253	7·15	97	5·70	58	3·97	149	7·19	45	4·58	0·3395

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

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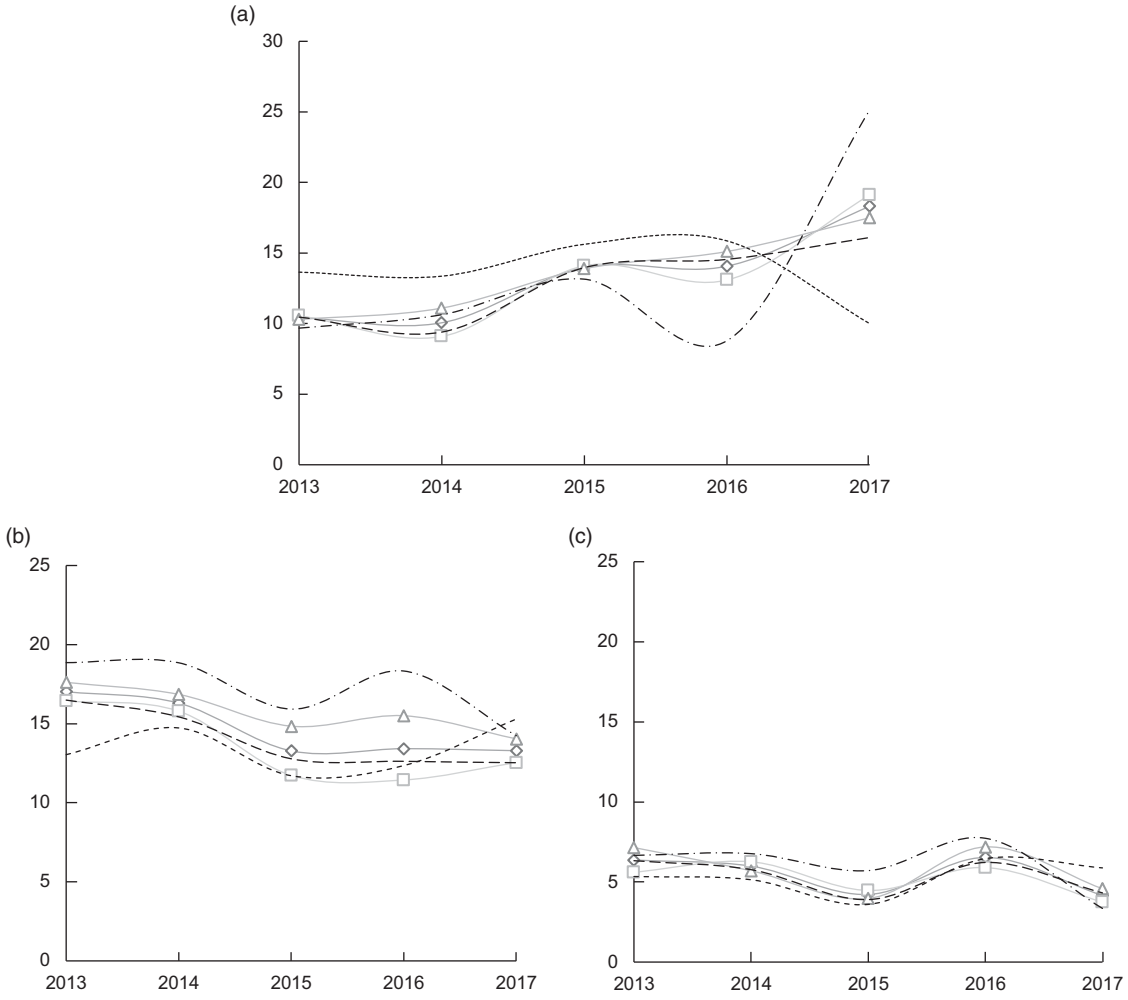

Fig. 1 Prevalence rates of (a) underweight, (b) overweight and (c) obesity among French children aged 4–12 years from 2013 to 2017. —◇—, total; —□—, boys; —△—, girls; -------, 4–6 years; – – –, 7–9 years; – · – ·, 10–12 years

among boys and girls ($P < 0{\cdot}01$) (Table 2). Conversely, the prevalence of underweight increased in girls and boys (from 10·0 to 20·0 %, $P < 0{\cdot}0001$) between 2013 and 2017.

Discussion

Many countries have developed public health initiatives and policies to prevent and treat unhealthy weight issues in children. Therefore, monitoring underweight, overweight and obesity in youth is essential for tracking and evaluating the effectiveness of these public health recommendations and intervention programmes. However, data on tracking in childhood are scarce, limited and missing among French children and adolescents since 2010[2].

Using the IOTF criteria, the results of the current study suggest that the prevalence of overweight changed significantly, showing a decrease between 2013 and 2017 (17·3–13·4 %). During the same period, obesity prevalence also decreased by 38 %, from 6·1 to 3·8 %, although not significantly. These findings concur with the results of a recent meta-analysis performed from 1999 to 2016 in European children[2]. The researchers reported that in some European countries during the last two decades, the growing overweight and obesity prevalence trend had reached a plateau or sometimes showed a slight decline[2]. A similar observation was made at the international level, especially in high-income countries[11]. Even though our data show encouraging results, the proportion remains high. Current national public health initiatives in children must be maintained and strengthened in the future.

Another outcome from our study is the difference in the prevalence of overweight and obesity between boys and girls. The prevalence rates of overweight and obesity were significantly higher in girls compared with boys; however, the sex differences were small (14·5 *v.* 16·4 % for overweight boys and girls; 5·2 *v.* 5·8 % for obese boys and girls). This finding is also consistent with results from previous studies[2,11,12].

Although the data on overweight and obesity prevalence from this survey are encouraging, another major concern was highlighted. Our results show an alarming

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progression of underweight between 2013 and 2017 among both boys and girls. The prevalence of underweight has effectively doubled in 5 years (10·0 *v.* 20·7 % and 10·5 *v.* 20·5 % for boys and girls, respectively). Previous studies have highlighted the maturing of this phenomenon and underlined the need for further attention[5,6,13]. Since underweight is also associated with adverse health consequences (physical, psychological and social) throughout the life course, there is an urgent need to develop strategies to reduce this growing prevalence. In addition, when monitoring overweight and obesity, we recommend also systematically assessing the rate of underweight prevalence.

The current study has strengths and limitations. One of the strengths is the large sample size of children with age- and sex-specific information across France. The use of standardised procedures to assess anthropometric measures is another strength. Although the present data derive from a large sample belonging to 65 % of the French administrative regions, the current study did not use a stratified sample design. Therefore, it is not possible to assume that the studied cohort is fully representative of the child population in France. In addition, our results showing increasing underweight and decreasing overweight profiles must be used with caution because we cannot exclude whether there was a general shift in the bell curve (or spreading out) or just a difference in our sample between measurement dates (2013–2017). Indeed, due to the voluntary nature of the programme, the number of participants studied across the years differed dramatically and may affect our results. Another potential weakness is the lack of socioeconomic information, which could have impacted our findings. A socioeconomic gradient in overweight and obesity was effectively reported in most partly developed countries, with a higher prevalence of overweight and obesity being observed in more disadvantaged groups[14,15]. Consequently, we recommend studies incorporating random subject selection and assessing socioeconomic status.

In summary, data from our study suggest a quite stable prevalence of obesity with a declining prevalence of overweight, despite remaining high in French children between 2013 and 2017. Our results also indicate that underweight increased significantly in both sexes. This concern becomes an important phenomenon in children and warrants careful monitoring in coming years. Based on the current results, we support the continuation of current public health policies and also encourage the development of new strategies to prevent and treat underweight issues.

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