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Factors associated with childhood obesity in Spain. The OBICE study: a case–control study based on sentinel networks

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Abstract

Objective: To estimate the association strength of dietary behaviour and sedentary habits in relation to childhood obesity in Spain.
Design: A matched case–control study was carried out using data collected by sentinel network paediatricians in general practices.
Setting: Five Spanish autonomous communities.
Subjects: Cases were 437 children (2–14 years old) with BMI >95th percentile according to Spanish reference tables. Controls were 751 children (2–14 years old; two paired per case) with BMI <84th percentile. Data were collected in two phases: individual (questionnaires filled in by sentinel paediatricians) and family (self-administered questionnaires filled in a family environment). Crude OR and adjusted OR (ORc and adj OR) for the given variables were calculated using a simple and multiple conditional logistic regression analysis.
Results: The factors with the greatest effect on obesity were family history of obesity: both parents (adj OR = 11·2), mother but not father (adj OR = 9·1), father but not mother (adj OR = 6·1), siblings (adj OR = 2·7); and eating between meals (adj OR = 2·5) and consumption of sweets and soft drinks >2 times/week (adj OR = 2·0). The highest protection effect was found for five meals per day (adj OR = 0·5), the regular consumption of breakfast (adj OR = 0·5) and for eating fruit for dessert (adj OR = 0·6). Factors related to sedentary habits did not appear as noteworthy.
Conclusions: We have determined the association between certain dietary behaviour and family history with childhood obesity in several Spanish regions.

Keywords
Childhood obesity
Case–control study
Sentinel network

Childhood obesity is determined by a complex interplay of genetic, environmental, behavioural and cultural factors, which lead to an energy imbalance. Social and cultural factors appear to play an important role in shaping the closest behavioural patterns that give rise to body weight gain(1).

In Spain, as well as in other developed countries, the prevalence of childhood obesity has increased in recent decades. From 1984 to 2000, the prevalence in children aged 6–12 years has multiplied by three(2). The highest increase was observed in 10-year-old boys(3).

There have been several cross-sectional studies carried out in Spain on childhood obesity that have allowed us to know the prevalence and its related factors, but there are few case–control design studies to determine factors with association(4–6). One of them(7) suggests that physical leisure-time activity, a family history of obesity, watching television (TV) and sugar-sweetened beverage consumption are important predictive variables for childhood obesity.

None of these case–control studies was carried out using primary health-care cases, but rather with hospital cases. Primary health care in Spain is a proxy of the general population, mainly in childhood, because of its proximity and coverage. Health sentinel networks have been working in the primary health-care level in Spain for >20 years(8), and they have proved the effectiveness of carrying out epidemiological studies with different designs in a quick and inexpensive way, because the data are collected during the standard consultation time.

Because childhood obesity is an important adult obesity predictor and a rising problem, we considered that it

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would be interesting to develop the possibility of using this easier way of studying with a case–control design for this topic.

The objective of the present study was to determine the association between dietetic behaviour, physical activity and obesity in children under 15 years of age in a large part of the Spanish population using sentinel networks with an age- and gender-matched case–control study design.

Methods

The OBICE (OBesidad Infantil en redes CEntinelas) study is a case–control study of childhood obesity and its determining factors in several Spanish regions (autonomous communities) carried out in sentinel networks.

The study population was recruited from 106 paediatric consultations in the sentinel networks of five regions (Asturias, Castilla y Leon, Extremadura, La Rioja and Comunitat Valenciana). These territories cover a population of 1 108 517 children (2–14 years of age; 20·4 % of the Spanish child population).

Children between 2 and 14 years of age attending a sentinel paediatric consultation (independent of the cause of consultation) were candidates considered eligible for inclusion in the present study. Cases were defined as children with a BMI >95th percentile (according to 'Fundación Orbegozo-Sobradillo' tables[9]) identified for the first time. Controls (two per case) were children with a BMI <84th percentile (according to the same reference tables) matched to the gender and age (±1 year) of cases. Sometimes it was not possible to obtain two controls per case, and then only one control was chosen. The study included 1188 individuals, 437 cases and 751 controls. Data were collected in 2007 and 2008.

Children with a pathology that could condition dietary habits and/or physical activity and/or weight and height development were excluded as cases. For controls, obesity as the cause of consultation and a prior diagnosis of obesity (controlled or treated by therapeutic or intervention procedures) were also causes for exclusion. The siblings of cases were excluded as controls. Parents or legal tutors provided consent for both cases and controls.

Two questionnaires were used: one to be filled in by each paediatrician in the practice and another to be filled in by the children's family (self-completed). Both included questions about food frequency.

The paediatrician's questionnaire included information about sex, age, weight and height, country of origin (for children and parents), family background (parental obesity and sibling obesity), personal background (breast-feeding, birth weight and height), physical activity (h/week), screen activities (time use) and dietary habits (breakfast, number of meals per day, whether fruit and vegetables are usually consumed, consumption of sweets and soft drinks per week).

The family's questionnaire also included information about parents' occupation and their educational level, children's sleeping hours, leisure-time physical activity, time spent watching TV, playing video games and using computer (h/week). A semi-quantitative FFQ was integrated into it, including breakfast composition, portions of several foods consumed per week, usual dessert and usual drink and place of the principal meal (school, parents' home or grandparents' home). The questions about food frequency are adapted as a short questionnaire from a validated questionnaire used in other studies[10] in 2005. For the analysis, the food frequency answers were categorized according to the recommendations of the Spanish Society of Community Nutrition[11], and the inadequate consumption by food group was calculated by comparison with Spanish dietary recommendations[12].

Statistical analysis

Data from both questionnaires were used. Means and 95 % CI for continuous variables and frequencies and percentages for categorical variables were calculated. When the measurement was in h/week, variables were categorized into two categories, indicating risk of obesity or not. A new category named 'not available' was created in some variables whenever data were incomplete in order to improve the power of the analysis. Social class was calculated through both parents' occupations and the family's social class was assigned according to the correspondence analysis method[13]. Differences of proportions between cases and controls for each categorical variable were analysed by simple conditional logistic regression[14]. The P values of the likelihood ratio test were used. Crude OR (ORc) and 95 % CI were also drawn from simple conditional logistic regression. As we intended to control the potential confounding effect of some of the variables, to estimate the simultaneous effects of multiple variables on the risk of childhood obesity, a multiple conditional logistic regression model with a forward stepwise selection method was performed. The χ^2 statistic score was used to assess the importance of each factor at each stepwise run. The statistical significance level required for inclusion was set at 0·10 and for those remaining in the model at 0·05. The adjusted OR (adj OR) was estimated with 95 % CI. Statistical analysis was performed using R statistical software[15] version 2·10·1 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Data from 1188 children were collected. The distribution between sentinel networks was proportional to their population. For 123 cases, two controls could not be obtained.

Table 1 shows a brief description of the principal variables used for matching, as well as the birth weight (g) and height (cm) and the BMI standard deviation score

Table 1 Characteristics of cases and controls for matching or continuous variables: OBICE study, Spain, 2007–2008

	Cases (*n* 437)		Controls (*n* 751)	
Variables	Mean	95 % CI	Mean	95 % CI
Age (years)	8·8	8·6, 9·2	8·8	8·6, 9·1
Sex (%)				
Boys	55·6		55·5	
Girls	44·3		44·4	
BMI-SDS (British 1990 reference)	2·773	2·729, 2·817	0·207	0·138, 0·275
Birth weight (g)	3289	3239, 3341	3191	3155, 3229
Height at birth (cm)	50·0	49·8, 50·2	49·8	49·6, 50·0

OBICE, OBesidad Infantil en redes CEntinelas; BMI-SDS, standard deviation score BMI.

(BMI-SDS; BMI was converted into SDS using the revised British 1990 reference)[16,17]. According to international standards criteria, we identified from our defined cases eighty-seven children as non-obese, but all of them were overweight according to the same criteria. For controls, there were ninety children with overweight according to international standards criteria but none of them were obese according to the same criteria.

The distribution for variables included in the paediatrician's questionnaire, their ORc, the respective 95 % CI and statistical significance test are presented in Table 2. In the crude analysis (non-adjusted), cases had a higher proportion of history of family obesity (parents or siblings) than did controls. Other identified obesity risk factors were the consumption of sweets and soft drinks >2 times/week, >3 h/d of screen activities and eating between meals.

In the crude analysis, dietary variables with a protection value and statistical differences between cases and controls were: consuming five meals per day, daily consumption of fruit, the usual consumption of vegetables, usual school refectory use, >2 h of leisure-time physical activity, regular consumption of breakfast, consuming fruit for dessert, a healthy breakfast, sleeping ≥10 h and not using soft drinks in meals as usual. The family's social class showed a *P* value equal to 0·005 with a difference between low (reference) and high family social class (ORc = 0·4). The parents' educational level (secondary education or more) showed an ORc of 0·7 for the mother's education and 0·6 for the father's education.

Table 3 shows the results of the semi-quantitative FFQ integrated into the family's questionnaire (ORc, 95 % CI and *P* values). In the crude analysis, some of the dietary factors showed a statistically significant difference ($P < 0·001$) between cases and controls. They were: recommended consumption of fish and a consumption of soft drinks <2 times/week.

Table 4 shows the result of the simultaneous effects of multiple variables on the risk of childhood obesity through the multiple conditional logistic regression analysis (adj OR, 95 % CI and *P* value). The factors with more effect on childhood obesity were those included in the family's history of obesity. The highest effect was for both parents' obesity: when both parents were obese the adj OR was 11·2. If the father was obese, but not the mother, the adj OR was 6·12. If the mother was obese, but not the father, the adj OR was 9·08. Siblings' obesity showed an adj OR close to 3·0. The dietary behaviour with a greater strength of association with obesity was snacking or eating between meals (adj OR = 2·5), followed by the consumption of sweets and soft drinks >2 times/week (adj OR = 2·0). The highest protection effect was found for consumption of five meals per day (adj OR = 0·5), regular consumption of breakfast (adj OR = 0·5) and consuming fruit for dessert (adj OR = 0·6). The other factor included in the final model was the consumption of meat, but the 95 % CI of the adj OR for more or less consumption was not significant.

Discussion

The main results of the OBICE study showed the importance of the family environment in several parts of Spain, especially parents' obesity, as a risk factor for childhood obesity. The results are not representative for the Spanish child population, but the regions included represent an important proportion of Spanish children (20·4 %). As far as we know, the present study is the first non-hospital-based case–control study on childhood obesity in Spain with a wide population framework, both geographically and proportionally.

The selection of cut-off points for obesity excluded the overlap between cases and controls. We chose a BMI value of >95th percentile for considering a child as obese because this was the criterion recommended and frequently used in epidemiological studies on childhood obesity[18–20]. Subsequent recommendations[3] indicate the use of the 97th percentile. Thus, it is possible that our case population includes individuals who could be categorized as overweight, meaning that the results underestimate some of the real effects of obesity; however, it is known[21] that the most frequently used Spanish tables (the Hernández tables[22]) overestimate obesity, hence the effect would be minor. Moreover, the quantity of cases between the 95th and 97th percentiles in our study

Table 2 Risk factors for childhood obesity from paediatrician's and family's questionnaires: OBICE study, Spain, 2007–2008

	Cases (*n* 437)		Controls (*n* 751)				
Risk factors	*n*	%	*n*	%	Crude OR	95 % CI	*P* value*
Parental obesity							<0·001
Father non-obese/mother non-obese (ref.)	176	40·3	623	83·0			
Father obese/mother non-obese	97	22·2	63	8·4	6·5	4·2, 10·0	
Father non-obese/mother obese	86	19·7	40	5·3	9·5	5·8, 15·5	
Father obese/mother obese	78	17·9	25	3·3	12·1	6·9, 21·2	
Siblings' obesity							<0·001
No (ref.)	144	32·9	334	44·4			
Yes	88	20·1	39	5·1	5·4	3·4, 8·8	
Not available	205	46·9	378	50·3	1·3	0·9, 1·8	
Breast-feeding							0·046
No (ref.)	70	16·0	114	15·1			
Yes	302	69·1	556	74·0	0·8	0·6, 1·2	
Not available	65	14·8	81	10·7	1·4	0·8, 2·5	
Five meals per day							<0·001
No (ref.)	140	32·0	147	19·5			
Yes	297	67·9	604	80·4	0·4	0·3, 0·6	
Daily consumption of fruit							<0·001
No (ref.)	250	57·2	333	44·3			
Yes	187	42·7	418	55·6	0·5	0·4, 0·7	
Usual consumption of vegetables							<0·001
No (ref.)	230	52·6	308	41·0			
Yes	207	47·3	443	58·9	0·6	0·4, 0·7	
Sweets and soft drinks consumption							<0·001
≤2 times/week (ref.)	195	44·6	510	67·9			
>2 times/week	224	51·2	221	29·4	2·8	2·1, 3·7	
Not available	18	4·1	20	2·6	2·1	1·0, 4·4	
Usual school refectory use							0·025
No (ref.)	331	75·7	531	70·7			
Yes	104	23·8	219	29·1	0·6	0·5, 0·9	
Not available	2	0·4	1	0·1	3·7	0·3, 41·8	
Screen hours (TV + computer)							<0·001
<3 h/d (ref.)	230	52·6	479	63·7			
≥3 h/d	182	41·6	237	31·5	1·8	1·3, 2·4	
Not available	25	5·7	35	4·6	1·5	0·9, 2·7	
Leisure-time physical activity (sport)							<0·001
<2 h/week (ref.)	246	56·2	339	45·1			
≥2 h/week	187	42·7	404	53·7	0·6	0·4, 0·7	
Not available	4	0·9	8	1·0	0·6	0·1, 2·5	
Regular consumption of breakfast							<0·001
No (ref.)	46	10·5	37	4·9			
Yes	391	89·4	714	95·0	0·3	0·2, 0·6	
Mother's educational level							0·084
Below secondary education (ref.)	251	57·4	380	50·6			
Secondary education or above	182	41·6	365	48·6	0·7	0·5, 0·9	
Not available	4	0·9	6	0·8	1·0	0·2, 3·7	
Father's educational level							0·008
Below secondary education (ref.)	251	57·4	367	48·8			
Secondary education or above	165	37·7	349	46·4	0·6	0·5, 0·8	
Not available	21	4·8	35	4·6	0·8	0·4, 1·4	
Family's social class							0·005
Low (ref.)	82	18·7	118	15·7			
Medium	290	66·3	483	64·3	0·8	0·6, 1·2	
High	35	8·0	112	14·9	0·4	0·2, 0·7	
Not available	30	6·8	38	5·0	1·1	0·6, 2·0	
Eating between meals							<0·001
No (ref.)	245	56·0	594	79·0			
Yes	192	43·9	157	20·9	3·0	2·3, 4·0	
Consuming fruit for dessert							<0·001
No (ref.)	307	70·2	441	58·7			
Yes	127	29·0	306	40·7	0·5	0·4, 0·7	
Not available	3	0·6	4	0·5	1·2	0·2, 5·5	
Healthy breakfast							0·007
No (ref.)	412	94·2	677	90·1			
Yes (milk + juice + corn flakes, bread or cookies)	25	5·7	74	9·8	0·5	0·3, 0·8	
Sleep							0·009
<10 h (ref.)	229	52·4	333	44·3			
≥10 h	204	46·6	411	54·7	0·6	0·4, 0·8	
Not available	4	0·9	7	0·9	0·7	0·2, 2·5	
Usual drink for meals							<0·001
Soft drinks (ref.)	73	16·7	61	8·1			
Non-soft drinks	357·0	81·6	663	88·2	0·4	0·3, 0·6	
Not available	7	1·6	27	3·6	0·2	0·0, 0·5	

OBICE, OBesidad Infantil en redes CEntinelas; ref., reference category; TV, television.
Results of the simple conditional logistic regression analysis of risk factors for childhood obesity are presented here.
*Likelihood ratio test.

Table 3 Risk factors for childhood obesity from family's questionnaire (semi-quantitative FFQ): OBICE study, Spain, 2007–2008

	Cases (*n* 437)		Controls (*n* 751)				
Risk factors	*n*	%	*n*	%	Crude OR	95 % CI	*P* value*
Consumption of dairy products							0·014
Not daily (ref.)	37	8·4	39	5·1			
Daily	396	90·6	710	94·5	0·5	0·3, 0·8	
Not available	4	0·9	2	0·2	2·2	0·4, 12·8	
Consumption of meat							0·091
>3 times/week (ref.)	342	78·2	626	83·3			
<2 times/week	89	20·3	120	15·9	1·3	0·9, 1·8	
Not available	6	1·3	5	0·6	2·3	0·7, 7·9	
Consumption of cold meat							0·972
Daily (ref.)	107	24·4	186	24·7			
Not daily	325	74·3	557	74·1	1·0	0·7, 1·3	
Not available	5	1·1	8	1·0	1·0	0·3, 3·6	
Consumption of fish							<0·001
<1 time/week (ref.)	126	28·8	141	18·7			
≥1 time/week	309	70·7	609	81·0	0·5	0·4, 0·7	
Not available	2	0·4	1	0·1	2·2	0·1, 26·6	
Consumption of eggs							0·956
Daily (ref.)	16	3·6	27	3·6			
Not daily	420	96·1	722	96·1	1·0	0·5, 2·0	
Not available	1	0·2	2	0·2	0·8	0·0, 9·9	
Consumption of vegetables							0·502
Not daily (ref.)	341	78·0	587	78·1			
Daily	92	21·0	161	21·4	0·9	0·7, 1·3	
Not available	4	0·9	3	0·4	2·4	0·5, 10·9	
Consumption of fruit							0·006
Not daily (ref.)	197	45·0	284	37·8			
Daily	234	53·5	463	61·6	0·7	0·5, 0·9	
Not available	6	1·3	4	0·5	2·3	0·6, 8·3	
Consumption of bread							0·414
Not daily (ref.)	73	16·7	104	13·8			
Daily	362	82·8	643	85·6	0·8	0·5, 1·1	
Not available	2	0·4	4	0·5	0·8	0·1, 4·6	
Consumption of rice, potatoes							0·375
3 times/week (ref.)	9	2·0	8	1·0			
<3 times/week	427	97·7	739	98·4	0·5	0·1, 1·4	
Not available	1	0·2	4	0·5	0·2	0·0, 2·9	
Consumption of fried foods							0·419
>3 times/week (ref.)	112	25·6	170	22·6			
<2 times/week	321	73·4	574	76·4	0·8	0·6, 1·1	
Not available	4	0·9	7	0·9	0·8	0·2, 3·0	
Consumption of pulses							0·053
<1 time/week (ref.)	66	15·1	84	11·1			
≥1 time/week	369	84·4	656	87·3	0·7	0·5, 1·0	
Not available	2	0·4	11	1·4	0·2	0·0, 1·1	
Consumption of pre-cooked meals							0·251
≥1 time/week (ref.)	133	30·4	209	27·8			
<1 time/week	299	68·4	538	71·6	0·8	0·6, 1·1	
Not available	5	1·1	4	0·5	1·9	0·5, 7·4	
Consumption of snacks							0·003
>3 times/week (ref.)	86	19·6	91	12·1			
<2 times/week	348	79·6	653	86·9	0·5	0·4, 0·7	
Not available	3	0·6	7	0·9	0·4	0·1, 1·9	
Consumption of cake, chocolate							0·745
≥1 time/week (ref.)	226	51·7	404	53·7			
<1 time/week	208	47·6	343	45·6	1·1	0·8, 1·4	
Not available	3	0·6	4	0·5	1·3	0·2, 6·0	
Consumption of sweets							0·098
>3 times/week (ref.)	95	21·7	124	16·5			
<2 times/week	339	77·5	622	82·8	0·7	0·5, 0·9	
Not available	3	0·6	5	0·6	0·7	0·1, 3·2	
Consumption of soft drinks							<0·001
>3 times/week (ref.)	124	28·3	105	13·9			
<2 times/week	310	70·9	645	85·8	0·3	0·2, 0·5	
Not available	3	0·6	1	0·1	2·7	0·2, 27·0	

OBICE, OBesidad Infantil en redes CEntinelas; ref., reference category.
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*Likelihood ratio test.

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Table 4 Multiple conditional logistic regression analysis of risk factors for childhood obesity: OBICE study, Spain, 2007–2008

Risk factors	Adjusted OR	95 % CI	*P* value*
Parental obesity			<0·001
Father non-obese/mother non-obese (ref.)			
Father obese/mother non-obese	6·1	3·8, 10·0	
Father non-obese/mother obese	9·1	5·1, 16·3	
Father obese/mother obese	11·2	5·9, 21·3	
Siblings' obesity			0·008
No (ref.)			
Yes	2·7	1·4, 5·0	
Not available	1·4	0·9, 2·1	
Regular consumption of breakfast			0·042
No (ref.)			
Yes	0·5	0·26, 0·98	
Five meals per day			0·002
No (ref.)			
Yes	0·5	0·3, 0·8	
Eating between meals			<0·001
No (ref.)			
Yes	2·5	1·7, 3·6	
Sweets and soft drinks consumption			<0·001
≤2 times/week (ref.)			
>2 times/week	2·0	1·4, 2·9	
Not available	2·1	0·8, 5·4	
Consuming fruit for dessert			0·002
No (ref.)			
Yes	0·6	0·4, 0·8	
Not available	7·5	0·7, 78·5	
Consumption of meat			0·020
>3 times/week (ref.)			
≤2 times/week	1·2	0·8, 1·8	
Not available	8·5	2·0, 36·5	

OBICE, OBesidad Infantil en redes CEntinelas; ref., reference category.
*Likelihood ratio test.

was relatively small. When we repeated the analysis, excluding cases and their associated controls between the 95th and the 97th percentiles (fifty-three cases and ninety-six controls), the results were essentially unchanged (results not shown).

Many studies emphasise the importance of parents' obesity, especially the mother's obesity, as a risk factor for childhood obesity[25–27], showing that parents' obesity and overweight increase the risk of childhood obesity. This is because, in addition to genetic factors, family members share behavioural risk factors including energy and percentage of fat intake, food preferences[28] and physical activity, which may influence children's weight later on. After performing the crude analysis, the final multivariate model excluded potential confounders such as breast-feeding[23], social class[24] and some dietetic factors and physical activity related to parental obesity[19]. The final model showed an association with parents' and siblings' obesity, highlighting the importance of obesity prevention in the family environment, involving fathers and mothers actively in acquiring knowledge to adopt healthy behaviour for diet and physical activity, because there is evidence of the long-term effectiveness of family-based treatment programmes for obese children[29].

The categorization as obese for parents and siblings was based on their own information and modified by the paediatrician's observations, but it was very difficult to make a direct measurement in a standard high-pressure health-care environment. Owing to this fact, our results are affected because informants systematically over-estimated the height and underestimated the weight of their family members[30,31], underestimating obesity (in approximately one person out of three)[32], but the bias could be partially made up for by face-to-face contact, which reduces it[33].

The results showed dietary factors as a main risk, such as eating between meals and the consumption of sweets and soft drinks >2 times/week. Although there is little information about meal frequency in children and adolescents, a similar pattern has been described[12] in Spanish children and young people, related to spending more time watching TV ('snacky' pattern). Other studies[34] have also related snacking to the consumption of snacks and soft drinks while watching TV. In the OBICE study, after adjusting screen activity hours (including TV), the factors remain, and snacking seems to be an important factor associated with childhood obesity independently of other behavioural or social factors. One limitation of our results is the lack of knowledge about the composition of this snacking. With regard to soft drink consumption, there is clear evidence[35] about the associations of soft drink consumption with increased energy intake and body weight in children, adolescents and adults[36]. Other studies carried out in Spain on

6–7-year-old children[37] showed that the impact of sweetened soft drinks, together with bakery products and yoghurt, on the quality of their diet is only modest.

The factors inversely associated with childhood obesity found in our study were meal frequency, regular consumption of breakfast and consumption of fruit for dessert. Bellisle *et al.*[38] have concluded that there does not appear to be a relationship between meal patterning and obesity; however, our results on meal frequency are consistent with those of other studies in children, in which a high meal frequency was inversely associated with childhood obesity[39,40], not explained by potential confounders.

There is a lot of evidence[41] that regularly consuming breakfast is a protective factor and skipping it is associated with childhood, adolescent and pre-school[42] obesity. The percentage skipping breakfast shown by the OBICE results is high (10·53 %) for obesity cases, particularly compared with results in Spanish adolescents presented in the AVENA (Alimentación y Valoración del Estado Nutricional en Adolescentes) Study (8·6 % in females and 3·5 % in males)[43], similar to the enKid study[44] (8·2 % for children and adolescents). To fight against childhood obesity it is necessary to promote breakfast as a main meal (15–20 % energy intake per day).

To consume fruit for dessert appears as an important protective factor. Increased fruit consumption has been associated[45] with a lower risk of a medium weight gain for adults, and the enKid study[44] in Spain has shown that a lower consumption of fruit and vegetables is associated with a higher prevalence of obesity. Regarding the behaviour of consuming fresh fruit for dessert, one of the bases of the Mediterranean diet pattern[46], and the relationship with childhood obesity, there is not enough evidence in the literature.

Factors related to sedentary habits did not appear as noteworthy in the final results, but the univariate analysis showed that controls presented a better situation than cases with regard to time for screen activities and physical activities. It is possible that they could be affected by a non-differential misclassification because of the measurement difficulties for physical activity variables, particularly in the health-care environment.

Previous studies in both children and adults have shown an increased prevalence of obesity associated with lower sleeping duration[47]. In our study, the apparent protective effect associated with $\geqslant$10 h of sleep seen in the univariate analysis was not statistically significant in the multivariate analysis. However, if sleep deprivation causes obesity through its effects on decreasing physical activity and activation of hormonal pathways leading to increasing appetite[48], our multivariate model might be overadjusting for the mechanisms that explain this relationship.

The use of sentinel networks implies strengths and weaknesses for this kind of survey with a case–control design. Its strength is that it is an easy way of conducting the study because the networks are ready to readdress the topic of study and conduct it within a short time; in addition, it is possible to obtain a sample closer to the general population than for other types of approximations. Its weakness is the participation of a lot of researchers with the possibility of different criteria. To avoid this, a study protocol with strict indications was distributed to each participant and the network coordination centres assumed the validation and homogenization task. Another difficulty was the selection of controls because at certain ages healthy non-obese children do not attend paediatric consultations. Therefore, it was not possible to obtain two controls for each case for all cases, but the proportion of cases (28·14 %) with only one control was relatively small. Finally, an important limitation was produced by the already mentioned auto-report of the parents' and sibling's obesity.

The OBICE study has shown the importance of obesity prevention in the family environment and the need to act on certain dietary habits in childhood, increasing the frequency of meals, reducing the consumption of sweets and soft drinks, promoting breakfast and healthy desserts. The results of the OBICE study also show the power of health sentinel networks to implement this type of epidemiological design.

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