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Prevalence and risk factors for obesity in Balearic Islands adolescents

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The aim of this work was to assess the prevalence and risk factors of obesity in the Balearic Islands' adolescents. A cross-sectional nutritional survey was carried out in the Balearic Islands (2007–2008). A random sample (*n* 1231) of the adolescent population (12–17 year old) was interviewed. Anthropometric measurements, two non-consecutive 24 h recalls and a general questionnaire incorporating questions related to sociodemographic and lifestyle variables including the physical activity questionnaire were used. The prevalence of overweight was 19·9 % (boys) and 15·5 % (girls), and obesity 12·7 % (boys) and 8·5 % (girls). The main risk factors associated with a higher prevalence of obesity were low parental education level (boys OR: 3·47; 95 % CI: 1·58, 7·62; girls OR: 3·29; 95 % CI: 1·38, 7·89), to skip meals (boys OR: 4·99; 95 % CI: 2·1, 11·54; girls OR: 2·20; 95 % CI: 0·99, 4·89), age (12–13-year-old boys; OR: 2·75; 95 % CI: 1·14, 6·64), attention to mass media (television (TV) + radio; boys OR: 1·50; 95 % CI: 0·81, 2·84; girls OR: 2·06; 95 % CI: 0·91, 4·68), short sleep (boys OR: 3·42; 95 % CI: 0·88, 13·26), low parental socioeconomic status (girls OR: 3·24, 95% CI: 1·04, 10·05) and smoking (girls OR: 2·51; 95 % CI: 0·88, 7·13). A programme of action including school healthy education and promotion programmes targeted at parents and adolescents are needed. These programmes may be mainly focused to increase educational level, to make the adolescents to be aware of to skip meals and to smoke are not appropriate methods to reduce the risk of obesity, but the usefulness is to do not eat while watching TV, to sleep 8–10 h/d and to be physically active.

Adolescents: Obesity: Overweight: BMI: Balearic Islands

The prevalence of overweight and obesity among children and adolescents has risen greatly worldwide, making them one of the most serious public health problems in this age group and in adulthood[1]. Childhood and adolescent excessive weight (overweight and obesity) are associated with significant immediate and long-term health risks[1,2]. About 70 % of obese adolescents grow up to become obese adults[2]. Childhood and adolescent obesity predict obesity in adulthood and increase the risk of adult morbidity and mortality[1,3].

Although there are both genetic and environmental causes of obesity, the increase in prevalence of obesity worldwide is likely to be more closely associated with changes in environmental factors[2]. Sociocultural factors as parental occupational status, maternal level of education, cultural and/or religious habits and the role of family and patterns of beauty are factors that have a strong influence on eating habits in adolescents[4]. Changes on physical activity patterns in youth as a result of adopting a major inactive lifestyle, increasing time spent watching television (TV), playing video games and Internet are also associated with obesity increases[1,2].

The aim of present study was to assess the prevalence and risk factors of obesity in adolescents of the Balearic Islands, a Mediterranean region.

Methods

Study design

The study is a population based cross-sectional nutritional survey carried out in the Balearic Islands between 2007 and 2008.

Selection of participants, recruitment and approval

The target population consisted of all inhabitants living in the Balearic Islands aged 12–17 years. The sample population was derived from residents aged 12–17 years registered in the scholar census of the Balearic Islands. The theoretical sample size was set at 1500 individuals in order to provide a specific relative precision of 5 % (type I error = 0·05; type II error = 0·10), taking into account an anticipated 70 % participation rate. The sampling technique included stratification according to municipality size, age and sex of inhabitants, and random selection within subgroups, with Balearic Islands' municipalities being the primary sampling units, and individuals within these municipalities comprising the final sample units. The interviews were performed at the schools. The final sample size was 1231 individuals (82 % participation). The reasons to not participate were (a) the subject declined to be interviewed; (b) the parents did not authorise the interview.

Abbreviations: EI, energy intake; PAL, physical activity level; TV, television.

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Anthropometric measurements

Height was determined using a mobile anthropometer (Kawe 44 444, Asperg, Germany) to the nearest millimetre, with the subject's head in the Frankfurt plane. Body weight was determined to the nearest 100 g using a digital scale (Tefal, sc9210, Rumilly, France). The subjects were weighed in bare feet and light underwear, which was accounted for by subtracting 300 g from the measured weight. Triceps and subscapular skinfold thickness were measured using a Holtain skinfold calliper (Tanner/Whitehouse, Crosswell, Crymych, UK), and the mean of three measurements (right arm) was used, and used to calculate body fat as described previously[5]. Anthropometric measurements were performed by well-trained observers in order to avoid the inter-observer coefficients of variation. According to the WHO growth standards for children and adolescents, the prevalence of overweight (BMI $\geq$ P85 $<$ P97) and obesity (BMI $\geq$ P97) was age- and sex-specific calculated[6]. Waist circumference and waist:hip ratio were calculated according to cut-off limits described elsewhere[7].

Energy and nutrient intakes

For energy intake (EI), two non-consecutive 24 h diet recalls were obtained from the participants. Well-trained dietitians administered the recalls and verified and quantified the food records. To estimate volumes and portion sizes, the household measures found in the subjects' own homes were used. Conversion of food into nutrients was made using a self-made computerised program based on Spanish[8,9] and European[10] food composition tables and complemented with food composition data available for Majorcan food items[11]. Misreporters were determined using the Black's modification[12] of the Goldberg *et al.* cut-off[13] for EI. To define underreporting, the lower cut-off value for the ratio between EI and BMR (EI/BMR) was calculated for boys and girls separately as 3 SD below the mean of the ratio between total energy expenditure[14] and BMR (total energy expenditure/BMR) for the 99 % lower confidence limit. With this calculation, the variation of EI, BMR and energy requirements are taken into account. In large studies ($n > 500$), the number of days of dietary assessment has a negligible effect on the cut-off values, and for measured BMR and 2 d of assessment, the coefficient variation used was 28·74 %[12]. The cut-off values were $>$1·56 EI/BMR for boys and $>$1·41 for girls. An EI/BMR $\geq$ 2·4 was considered to represent overreporting[15,16]. Underreporters (20 %) and overreporters (2 %) were excluded from the analysis of dietary patterns.

General questionnaire

The study population was divided into two categories according to their BMI: obese (BMI $\geq$ P97) and non-obese (BMI $<$ P97). A questionnaire incorporating the following questions was used: age group; region of origin (defined as being born in the Balearic Islands, East of Spain as a representative of the Spanish Mediterranean coast, other parts of Spain and other countries); parental educational level (grouped according to years and type of education: low, $<$6 years at school; medium, 6–12 years of education; high, $>$12 years of education); parental socioeconomic level (based on the occupation of parents and classified as low, medium and high, according to the methodology described by the Spanish Society of Epidemiology[17]).

Information about smoking habits, alcohol intake, sweets and salty snacks (potato chips, maize chips, ready-to-eat pop maize, pork rinds, potato sticks, extruded snacks and cheese puffs) consumption and breakfast habits were collected as described: smoking habit (no; yes; occasionally; $<$1 cigarette/d); alcohol consumption (no; frequently; occasionally; $<$1 drink/week); sweets and salty snacks consumption (yes; occasionally; no); breakfast daily (yes; occasionally; no).

The number of daily meals was calculated using the total of eating occasions that subjects declared to made among the following: breakfast; mid-morning snack; lunch; mid-afternoon snack; dinner; before going to sleep; others. Three groups of eating frequency were considered: $\leq$3; 4; $\geq$5 times/d.

Distraction during mealtime was studied using different possibilities: (1) watching the TV; (2) listen to the radio; (3) get up from the table; (4) conversation during mealtime. These variables were joined and expressed as (1) attention to mass media (TV + radio); (2) others.

Physical activity was evaluated according to the guidelines for data processing and analysis of the international physical activity questionnaire[18] in the short form and its specific modification for adolescents (IPAQ-A)[19]. The specific types of activity assessed were walking, moderate-intensity activities (i.e. physical activity at school) and vigorous-intensity activities (i.e. sport practice) and an additional question about sitting time was using as an indicator variable of time spent in sedentary activity. The questionnaire also included information on hours per day of TV viewing, computer use, video games, another leisure time physical activity practice and typical sleep duration to the nearest 10 min. The physical activity assessed by the international physical activity questionnaire was correlated with physical activity level (PAL) according to the estimation of the individualised activity coefficient. Each subject was classified taking into account its PAL value[20] as: sedentary (PAL $\geq$ 1·0 $<$ 1·4); low active (PAL $\geq$ 1·4 $<$ 1·6); active (PAL $\geq$ 1·6 $<$ 1·9); very active (PAL $\geq$ 1·9). Each subject was then classified into no active (sedentary or low active) and active (active or very active).

Differences in EI between BMI $<$ P97 and BMI $\geq$ P97 subjects were also studied. Total EI (MJ), energy (kJ) per kg of weight, energy (kJ) per kg of lean body mass and percentage of energy from macronutrients were taken into consideration for this analysis.

Statistics

Analyses were performed with SPSS version 16.0 (SPSS, Inc., Chicago, IL, USA). All tests were stratified by sex. Significant differences in prevalence were calculated by means of χ^2. Difference between groups' means was tested using ANOVA. Logistic regression models with the calculations of corresponding adjusted OR and 95 % CI were used to examine possible differences between those with BMI below or above P97. Univariate analysis was first carried out for all the sociodemographic and lifestyle variables that could be associated with the frequency of obesity. Any factor that was significantly associated was considered as a candidate for the multivariate model. Multiple logistic regression analyses were used to simultaneously examine the effect of different sociodemographic and lifestyle variables on the prevalence of obesity. The study of possible differences in food patterns between those obese and non-obese was adjusted by confounding factors. All correlations were investigated with Spearman's rank correlation coefficient (r). Level of significance for acceptance was $P<0·05$.

Ethics

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects/patients were approved by the Balearic Islands Ethics Committee. Written informed consent was obtained from all subjects and their parents or legal tutors.

Results

The overall prevalence of overweight and obesity estimated for the adolescent population of the Balearic Islands was 17·5 and 10·4 %, respectively (Table 1). Boys had a higher prevalence of overweight and obesity than girls. Excessive weight considered overall (BMI ≥ P85) was 32·6 % in boys and 24·0 % in girls. Prevalence of obesity (BMI ≥ P97) was higher in boys (12·7 %) than girls (8·5 %), and this difference was evident at 12–13 years old. Boys also showed higher waist circumference values and waist:hip ratio than girls, and girls showed higher hip circumference than boys after they were 14 years old. More girls than boys were above the cut-off values established for the waist circumference indicators of cardiovascular risk. Girls showed higher body fat mass than boys.

The univariate analysis with sociodemographic and lifestyle variables (Table 2) showed that the risk of obesity was associated with parental education level and number of daily meals in both sexes, age in boys, and parental socioeconomic status and current smoking habit in girls. The multivariate analysis showed that the risk of obesity increased in younger boys and in girls who were not active, in boys and girls who usually distracted during mealtime by means of mass media (TV + radio) and in boys who sleep <7 h daily, despite the lack of

Table 1. Anthropometric characteristics and prevalence of obesity and overweight of study participants
(Mean values and standard deviations or percentages)

	Total (n 1231)		Boys (n 574)		Girls (n 657)		
	Mean	SD	Mean	SD	Mean	SD	P
BMI (kg/m^2)*	21·8	3·65	21·7	3·59	21·8	3·70	0·635
12–13 years	20·9	3·66	20·9	3·58	20·8	3·73	0·773
14–15 years	21·8	3·51	21·7	3·53	21·9	3·50	0·448
16–17 years	22·5	3·74	22·4	3·60	22·6	3·87	0·752
Prevalence of overweight (%)†	17·5		19·9		15·5		0·052
12–13 years	18·8		15·3		21·8		0·176
14–15 years	19·6		24·9		15·1		0·003
16–17 years	12·4		14·4		10·6		0·324
Prevalence of obesity (%)†	10·4		12·7		8·5		0·020
12–13 years	14·8		21·0		9·5		0·008
14–15 years	9·8		11·3		8·5		0·252
16–17 years	7·7		7·9		7·5		0·893
WC (cm)*	69·7	8·40	72·6	8·14	67·3	7·84	0·000
12–13 years	67·6	8·69	69·9	8·23	65·6	8·61	0·000
14–15 years	69·9	7·97	72·7	7·60	67·6	7·51	0·000
16–17 years	71·4	8·58	74·8	8·40	68·3	7·53	0·000
WC > cut-off limits[9] (%)†	6·8		4·4		8·8		0·003
12–13 years	9·6		6·5		12·2		0·111
14–15 years	5·8		3·0		8·2		0·008
16–17 years	6·0		5·0		6·9		0·505
Hip circumference (cm)*	92·8	9·59	91·7	9·23	93·6	9·80	0·001
12–13 years	88·6	9·77	87·6	10·19	89·4	9·36	0·132
14–15 years	93·4	9·27	92·3	8·42	94·2	9·85	0·013
16–17 years	95·4	8·80	94·2	8·64	96·4	8·84	0·032
WHR*	0·76	0·097	0·79	0·047	0·72	0·116	0·000
12–13 years	0·77	0·080	0·80	0·045	0·74	0·091	0·000
14–15 years	0·75	0·117	0·79	0·046	0·72	0·146	0·000
16–17 years	0·75	0·064	0·79	0·050	0·71	0·047	0·000
WHR > cut-off limits[18] (%)†	0·3		0·2		0·5		0·403
12–13 years	0·7		0·0		1·4		0·194
14–15 years	0·2		0·0		0·3		0·360
16–17 years	0·3		0·7		0·0		0·283
Fat body mass (%)*	23·2	7·34	20·1	7·97	25·7	5·62	0·000
12–13 years	23·9	7·32	22·0	8·39	25·5	5·85	0·000
14–15 years	23·7	7·26	20·6	7·98	26·2	5·48	0·000
16–17 years	21·6	7·30	17·5	6·91	25·1	5·64	0·000

WC, waist circumference; WHR, waist:hip ratio.
* Significant differences between men and women by ANOVA.
† Significant differences between men and women by χ^2.

Table 2. Sociodemographic and lifestyle characteristics of non-obese (BMI < P97) and obese (BMI ≥ P97) adolescents (OR and 95 % CI values)

	Boys								Girls							
	BMI < P97 (*n* 501)		BMI ≥ P97 (*n* 73)						BMI < P97 (*n* 601)		BMI ≥ P97 (*n* 56)					
	n	%	*n*	%	Crude OR	95 % CI†	Adjusted OR	95 % CI‡	*n*	%	*n*	%	Crude OR	95 % CI†	Adjusted OR	95 % CI‡
Age group (years)																
12–13	107	81·1	28	18·9	2·54	1·16, 5·57*	2·75	1·14, 6·64*	140	91·0	15	9·0	1·18	0·51, 2·72		
14–15	255	87·6	33	12·4	1·54	0·75, 3·19	1·52	0·69, 3·37	306	91·0	28	9·0	1·19	0·59, 2·42		
16–17	139	91·6	12	8·4	1·00	Ref.	1·00	Ref.	155	92·3	13	7·7	1·00	Ref.		
Place of birth																
Non-Spanish	76	91·7	8	8·3	0·58	0·22, 1·51			112	90·7	12	9·3	1·08	0·52, 2·24		
Others from Spain	33	87·1	6	12·9	0·94	0·32, 2·80			33	90·3	4	9·7	1·13	0·33, 3·89		
East of Spain	13	100·0	0	0·0	0·00	0·000			23	95·2	1	4·8	0·53	0·07, 4·04		
Balearic Islands	379	86·4	59	13·6	1·00	Ref.			433	91·3	39	8·7	1·00	Ref.		
Parental socioeconomic status																
Low	98	86·7	14	13·3	1·53	0·60, 3·89			149	89·2	17	10·8	3·24	1·04, 10·05*		
Medium	290	86·3	46	13·7	1·59	0·74, 3·44			319	89·5	33	10·5	3·14	1·08, 9·11*		
High	113	90·9	13	9·1	1·00	Ref.			133	96·4	6	3·6	1·00	Ref.		
Parental educational level																
Low	162	81·6	33	18·4	2·99	1·46, 6·12**	3·47	1·58, 7·62**	212	86·1	31	13·9	3·75	1·60, 8·79**	3·29	1·38, 7·89**
Medium	148	86·2	24	13·8	2·12	0·99, 4·53	2·35	1·04, 5·34*	199	92·5	15	7·5	1·87	0·74, 4·76*	1·89	0·73, 4·94*
High	191	93·0	16	7·0	1·00	Ref.	1·00	Ref.	190	95·9	10	4·1	1·00	Ref.	1·00	Ref.
Hours of sleep (h/d)																
< 7	34	77·8	6	22·2	2·03	0·64, 6·37	3·42	0·88, 13·26	54	90·9	4	9·1	1·06	0·36, 3·09		
≥ 7	467	87·6	67	12·4	1·00	Ref.	1·00	Ref.	547	91·4	52	8·6	1·00	Ref.		
Number of meals																
1–3	122	79·2	31	20·8	4·87	2·20, 10·82***	4·99	2·1, 11·54***	257	88·3	34	11·7	1·78	0·85, 3·77*	2·20	0·99, 4·89*
4	175	85·6	31	14·4	3·11	1·41, 6·88**	2·60	1·13, 5·98*	192	94·5	11	5·5	0·78	0·32, 1·93	0·83	0·32, 2·16
≥ 5	204	94·9	11	5·1	1·00	Ref.	1·00	Ref.	152	93·1	11	6·9	1·00	Ref.	1·00	Ref.
Breakfast habit																
Yes	385	88·5	52	11·5	0·50	0·22, 1·17			377	93·6	26	6·4	0·56	0·26, 1·20		
Occasionally	75	85·1	12	14·9	0·68	0·25, 1·85			122	87·3	17	12·7	1·19	0·53, 2·69		
No	41	79·5	9	20·5	1·00	Ref.			102	89·1	13	10·9	1·00	Ref.		
Sweets or salty snacks																
Yes	99	90·7	9	9·3	0·77	0·32, 1·83			144	93·2	11	6·8	0·59	0·26, 1·33		
Occasionally	161	84·8	29	15·2	1·35	0·74, 2·46			181	92·2	17	7·8	0·68	0·36, 1·29		
No	241	88·2	35	11·8	1·00	Ref.			276	89·0	28	11·0	1·00	Ref.		
Attention to mass media (TV + radio)																
Yes	320	86·0	52	14·0	1·52	0·81, 2·84			427	90·7	44	9·3	2·06	0·91, 4·68		
No	131	90·3	14	9·7	1·00	Ref.			140	95·2	7	4·8	1·00	Ref.		
Alcohol consumption																
Yes	194	90·8	21	9·2	1·09	0·61, 1·97			365	90·9	24	9·1	0·55	0·30, 1·01		
No	307	84·4	52	15·6	1·00	Ref.			236	91·6	32	8·4	1·00	Ref.		
Current smoking habit																
Yes	37	91·2	3	8·8	0·66	0·19, 2·28			35	85·7	5	14·3	2·51	0·88, 7·13		
Occasionally	290	86·1	42	13·9	1·10	0·62, 1·93			359	88·8	33	11·2	1·89	1·02, 3·51*		
No	174	87·2	28	12·8	1·00	Ref.			207	93·8	18	6·2	1·00	Ref.		
Physical activity level																
No active	161	83·7	33	16·3	1·57	0·91, 2·73			346	89·7	38	10·3	1·68	0·91, 3·12	1·87	0·96, 3·64
Active	340	89·0	40	11·0	1·00	Ref.			255	93·6	18	6·4	1·00	Ref.	1·00	Ref.

Ref., reference.

† Univariate analysis (logistic regression analysis considering the effect of one explanatory variable): significant differences (* $P < 0·05$, ** $P < 0·01$, *** $P < 0·001$).

‡ Multivariate analysis (multiple logistic regression analysis considering the simultaneous effect of all explanatory variables): significant differences (* $P < 0·05$, ** $P < 0·01$, *** $P < 0·001$).

statistical significance; an inverse association between parental education level and number of daily meals, and BMI in boys and girls was also found. None of the other lifestyle variables considered in the present study (place of birth, breakfast habit, sweets or salty snacks consumption and alcohol consumption) was significantly associated with obesity in any sex.

A positive correlation between sugar-sweetened beverages consumption and watching TV was found (r 0·123, $P<0·001$). However, no significant association between sweetened-beverages consumption and body weight status was found.

Although no significant difference in sedentary behaviour was found between obese and non-obese adolescents, high body fat (≥P85) was associated with a less time spent in vigorous-intensity physical activities in both boys (r −0·174, $P<0·001$) and girls (r −0·102, $P<0·05$).

Table 3 shows dietary characteristics of obese and non-obese boys and girls excluding misreporters. No statistical significant difference in prevalence of misreporters was observed between obese and non-obese subjects (data not shown). Obese boys and girls reported a significant lower intake of energy than non-obese adolescents. There were no differences in the dietary origin of the energy between obese and non-obese adolescents.

Discussion

The present results reveal the magnitude of overweight and obesity among 12–17-year-old adolescents in Balearic Islands. The observed percentages of prevalence of overweight (boys 19·9 %; girls 15·5 %) and obesity (boys 12·7 %; girls 8·5 %) among adolescents in Balearic Islands are higher in boys than girls as in most European countries[21]. In comparison with other data, despite differences in ages studied and the percentile considered as indicator of obesity in adolescents (we considered the 97th percentile), prevalence of overweight and obesity is higher than in Portugal (overweight 16·6 % boys and 12·9 % girls; obese 3·6 % boys and 2·7 % girls), Belgium (overweight 8·6 % boys and 7·4 % girls; obese 1·8 % boys and 1·5 % girls) and Ireland (overweight 17 % boys – exception girls, which has a high prevalence, 21 %; – obese 6 % boys and 7 % girls), whereas the prevalence of obesity is lower and the prevalence of overweight is higher than in the enKid Study of the Spanish population (obese 15·8 % boys and 9·1 % girls; overweight 10·4 % boys and 8·0 % girls), Canary Islands (obese 12·0 % boys and 17·6 % girls; overweight 10·8 % boys and 11·9 % girls), Germany (obese 13·9 % boys and 11·7 % girls; overweight 12·5 % boys and 10·2 % girls) and the United States (obese 16·7 % boys and 15·4 % girls; overweight 14·5 % boys and 15·1 % girls)[22–26].

The association between sociodemographic and lifestyle factors and BMI in adolescents of the Balearic Islands showed that parental education level is one of the strength factors associated with prevalence of obesity in boys and girls, which agrees data reported by other authors[27].

Multiple logistic regression analysis also revealed an inverse association between age and obesity in boys. Previous studies pointed out that the trend in the prevalence of overweight (including obesity) decreases with age in adolescents[28].

Previous works reported that girls paid more attention to foods than boys as a way to influence health and to meet nutritional recommendations and then to prevent or to reverse the obese state[29]. We have observed that both obese boys and girls reduced the number of meals per day, skipped the breakfast and avoided sweets and salty snacks consumption, which is more evident in girls, as a method to counteract the obesity.

We observed an inverse association between obesity and the number of daily meals, which is observed in boys and

Table 3. Energy and nutrient intakes and selected food group consumption in non-obese (BMI < P97) and obese (BMI ≥ P97) adolescents

(Mean values and standard deviations)

	BMI < P97		BMI ≥ P97			
	Mean	SD	Mean	SD	Crude analysis†	Adjusted analysis‡
Boys§						
EI (MJ)	9·7	3·44	8·0	3·25	*	**
EI (kJ/kg per d)	164·9	61·40	98·2	39·84	**	**
EI (kJ/kg lean body mass per d)	200·9	72·26	143·6	57·03	**	**
Energy from CHO (%)	45·5	7·98	45·6	10·10	NS	NS
Energy from total fat (%)	37·5	7·01	37·5	9·41	NS	NS
Energy from SFA (%)	13·4	3·86	12·8	4·94	NS	NS
Energy from proteins (%)	16·9	4·40	16·8	3·88	NS	NS
Girls‖						
EI (MJ)	7·7	2·63	5·7	2·47	**	**
EI (kJ/kg per d)	144·5	56·9	71·9	30·76	**	**
EI (kJ/kg lean body mass per d)	192·0	71·66	114·5	48·15	**	**
Energy from CHO (%)	44·2	8·96	44·8	11·90	NS	NS
Energy from total fat (%)	38·6	7·98	36·0	9·96	NS	NS
Energy from SFA (%)	13·3	4·04	11·9	4·72	NS	NS
Energy from proteins (%)	17·2	4·87	19·0	6·14	NS	NS

EI, energy intake; CHO, carbohydrates.
† Crude analysis: significant differences (* $P<0·01$, ** $P<0·001$) between group means by ANOVA.
‡ Adjusted analysis: significant differences (** $P<0·001$) after controlling for age by multiple logistic regression.
§ Boys: n 306 and 36 for BMI < P97 and BMI ≥ P97, respectively.
‖ Girls: n 351 and 34 for BMI < P97 and BMI ≥ P97, respectively.

girls. This inverse association between obesity and meal frequency is in agreement with previous studies developed in children[30,31].

We detected a greater risk to be obese in adolescents that do not have breakfast, despite the lack of statistical significance. The omission or consumption of an inadequate breakfast is usual in adolescents[32], although its consumption has been identified as an important factor in the nutritional well being of children and it is rarely compensated for in other meals of the day[27]. Adolescents must be conscience that to skip meals is not an appropriate method to reduce the risk of obesity[31].

We also found that adolescents showed low risk of obesity when they usually consume sweets and salty snacks, which may sound controversial. It may be possible that they underreported their sweets and salty snacks consumption. However, both obese boys and girls consume proportionally less sweets and salty snacks than their lean pairs; it may be a method to self-control their body weight.

A positive association between BMI and distraction during mealtime has been detected, and many adolescents are distracting especially watching the TV (68·4 % of boys; 72·1 % of girls) and listen to the radio (13·0 % of boys; 14·6 % of girls), compared with those that declared to get up from the table (14·0 % of boys; 18·2 % of girls) and to speak during mealtime (57·4 % of boys; 67·5 % of girls). Different studies have detected a positive association between BMI and body fatness and TV among children and adults[33,34]. Despite TV viewing being linked to lower physical activity, Jackson *et al.*[34] suggested that the relation between TV viewing and fatness is more likely to be due to an effect on food intake. TV viewing during mealtime is inversely associated with consumption of products not advertised, such as fruits and vegetables[1]; leads to more eating and encourages the consumption of ‘socially prestigious’, ‘healthy’ and/or ‘tasty’ foods and drinks[27]; and a large proportion of televised food advertisements are for highly processed ‘junk foods’[27]. In agreement with a previous study[35], sugar-sweetened beverages’ consumption was positively correlated to watching TV, but no significant association between sweetened-beverages’ consumption and body weight status was found. Controversial results about sugar-sweetened beverage consumption and body weight can be found in the literature[35,36], which may be explained in part by differences in the design of the study, in definitions of sugar-sweetened beverages and methodological bias in self-reported data. Overall, adolescents must be conscience that watching the TV during mealtime is not a good practice to have a healthy diet, and health promotion plans must be devoted of it.

Short sleep (≤7 h/d) is associated with obesity compared with longer sleep in boys, whereas no association has been found in girls. These results agree previous studies that suggested a negative association between usual sleep duration and obesity or body weight in children and adults[37,38]. Other studies suggest that boys are more susceptible to sleep less than girls[39]. However, recent reviews of the epidemiological evidence have now pointed out that it is still precipitous to suggest that sleep is a cause or solution to the obesity epidemic and further studies are needed[37,38].

Adolescence is a time of rapid physiological, psychological and social development, and also a key period for the adoption of tobacco use. Is there any relationship between obesity and smoking habit in adolescents? Smoker girls showed higher risk of obesity than non-smokers, whereas usually smoking habit was associated with a low risk of obesity in boys. Previous studies showed similar BMI, energetic intake and fat intake among smokers and non-smokers, in spite of 40 % adolescents believed that smoking will decrease or control their weight[40]. This belief may be supported by the fact that smoke decreases the taste threshold and also girls exhibit greater taste sensitivity than boys, and these differences are of hormonal nature[41]. Consequently, girls apply this method to ‘reduce’ their weight because girls are usually more worried about their image than boys; however, it cannot be discarded that to smoke may also be a facilitating factor of social relationships[42]. Adolescents need to be more aware about this unhealthy behaviour, so education programmes related to healthy behaviours are needed in adolescence to prevent future health problems.

We also observed that EI is lower in non-obese than in obese boys and girls, with no differences in the dietary origin of the energy. This paradoxical effect could be attributed to the validity of the instruments to measure food consumption in the population. It is also possible that obese adolescents overestimated the consumption of healthy food items and underestimated the consumption of unhealthy foods, because it has been well documented that people with greater relative weight usually underreported their food intake[5].

The 24 h recalls provide information on food intake, and because the data collection occurs after consumption, this method does not affect an individual’s food choices on a given day[43]. At least, two non-consecutive administrations are necessary to assess usual intakes, to reduce dependency on intake from the previous day and by household food availability[43]. Accordingly, we applied two 24 h non-consecutive recalls in the present study.

Although 24 h recalls collect data soon after intake, recalls have also limitations related to memory and bias[43]. Difficulties assessing portion sizes could also contribute to underestimation of EI[44]. Many adolescents have found it difficult to estimate their consumption of some foods, and the consequence of difficulties in assessing high energy-dense foods may be that consumed amounts are underestimated, which, in turn, may have a great effect on the validity of the reported EI[44]. Underreporting and overreporting are significant contributors to the systematic bias of self-reported dietary assessments, increasing or decreasing estimates of the incidence of inadequate intake and distorting the relationships between nutrient intake and health. Therefore, there are real shortcomings in dietary studies.

To solve these shortcomings, it has been pointed out[12] that dietary studies should include an internal validation procedure. Biomarkers of EI have been suggested to play a useful role in dietary assessment, especially for components of foods that are highly variable within different samples of the same food. However, biomarkers, even when available, also have many limitations[45]. Advantages and limitations of each must be carefully considered in any specific application, but the mainstay of nutritional epidemiology will remain assessments of dietary intake.

Since 1995, the Goldberg *et al.* cut-off[13] has been used to identify EI misreporters. However, the Goldberg cut-off has been usually misinterpreted. Black[12] restates the principles underlying the Goldberg cut-off for identifying underreporters of EI. According to Black contributions[12], the Goldberg cut-off can be used to determine the degree of overall bias to reported EI in a dietary assessment. Comparison should be made with a PAL value appropriate to the study population based on information about physical activity or lifestyle. A short questionnaire on home, leisure and occupational activity such that subjects may be assigned to low, medium or high PAL for calculating the Goldberg cut-off should be included as routine. One comparison of a simple questionnaire and a detailed activity diary has suggested that the former might be adequate for large-scale studies[46]. Therefore, we used the Black's modification of Goldberg cut-off to solve the EI misreporting, in spite of that we are conscious that this is just an approximation to the misreporting problem, and that the solution of EI misreporting still needs further research. A late validation study[44] of dietary assessment methods using double-labelled water in children and adolescents founded, however, similar percentages of EI misreporters to ours.

Physical activity is a complex multidimensional exposure, which is difficult to measure by self-reported questionnaires in epidemiological studies[47]. Self-report of physical activity can lead to overreport it due to a social desirability bias, and therefore the number of inactive individuals may be greater than that reported[48,49], especially among children and adolescents, and also among obese[48]. Questionnaires have inherent limitations, mainly because they are subjective in nature. Limitations in the validity of physical activity questionnaires are considered the main reasons for inaccuracies in epidemiological studies.

An extensive range of instruments for measuring physical activity has been reported in the literature, but critical elements in the utility of an instrument to measure physical activity are that it will be relatively inexpensive, cause minimal inconvenience to the participant and be able to be administered with relative ease[50].

Furthermore, Black's modification of Goldberg cut-off and many of the methodological challenges that face nutritional epidemiology are mirrored in the assessment of physical activity. It is well established that a sedentary lifestyle with a low level of energy expended on physical activities is a risk factor of weight gain[5]. We found that the risk of obesity is higher in physically inactive adolescents than in active adolescents, despite the lack of statistical significance. Balearic Islands' obese and non-obese adolescents showed no different sedentary behaviour, but high body fat was associated with a less time devoted to vigorous-intensity physical activities in both boys and girls. One of the worldwide suggested factors for obesity prevention is to encourage the physical activity practice, which decreases annually about 2·7 % among boys and 7·4 % among girls between the ages of 10 and 17[29].

However, the capacity to convert these physiological data to estimates of energy expenditure at low and high intensities of effort requires clarification[51]. The intensity of the physical activity needs to be assessed relative to each individual's physiologic capacity, and referenced to resting metabolism or maximal aerobic capacity. There are still shortcomings in the employment of instruments to measure physical activity. So, questionnaires on detailed activity diary might be adequate for large-scale studies[46].

Conclusions

To sum up, the prevalence of overweight and obesity in the Balearic Islands' adolescents should take into consideration. The main risk factors associated with prevalence of obesity in adolescents are the age, the parental education level, to skip meals, the distraction during mealtime, a short sleep and the current smoking habit. A programme of action including school healthy nutritional education and promotion programmes targeted at parents and adolescents is needed. These programmes may be mainly focused to increase educational level, to make the adolescents to be aware of to skip meals and to smoke are not useful methods to reduce the risk of obesity, but to do not eat while watching TV, to sleep 8–10 h/d and to be physically active.

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