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Family structure and childhood obesity: results of the IDEFICS Project

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Abstract

Objective: To analyse the association between family structure and adiposity in children.
Design: Cross-sectional and longitudinal analysis of the IDEFICS (Identification and prevention of dietary- and lifestyle-induced health effects in children and infants) study cohort.
Setting: Primary schools and kindergartens.
Subjects: Children (*n* 12 350; aged 7·9 (SD 1·8) years) for the cross-sectional analysis and children (*n* 5236; at baseline: normal weight, aged 5·9 (SD 1·8) years) for the longitudinal study underwent anthropometry. Family structure was analysed as (i) number and type of cohabiting adults and (ii) number of siblings.
Results: In the cross-sectional analysis, after controlling for covariates, children living with grandparents had significantly higher BMI *Z*-score than those living with both parents (0·63; 95 % CI 0·33, 0·92 *v.* 0·19; 95 % CI 0·17, 0·22; $P < 0·01$); in addition, the higher the number of siblings, the lower the BMI *Z*-score (only child = 0·31; 95 % CI 0·24, 0·38; 1 sibling = 0·19; 95 % CI 0·16, 0·23; 2 siblings = 0·15; 95 % CI 0·09, 0·20; >2 siblings = 0·07, 95 % CI 0·04, 0·19; $P < 0·001$). Over the 2-year follow-up, differences in weight gain were observed across family-structure categories. Further, the risk of incidence of overweight/obesity was significantly lower the higher the number of siblings living in the household (*v.* only child: 1 sibling = 0·74, 95 % CI 0·57, 0·96; 2 siblings = 0·63, 95 % CI 0·45, 0·88; >2 siblings = 0·40, 95 % CI 0·21, 0·77), independently of confounders.
Conclusions: The study suggests that an independent association between family structure and childhood obesity exists.

Keywords
Family structure
Childhood obesity
Siblings
Grandparents
Cohabiting

The prevalence of childhood overweight and obesity is increasing rapidly worldwide and is recognized as a leading threat to public health[1,2]. Genetic, environmental and social factors have been proposed as potential causal factors and, among the latter, recent studies have suggested a possible role for family structure[3].

In recent decades, major changes have occurred in family structure in Western countries. For example, the modern family is often composed of one or two children and two parents working outside the home, standing in contrast to a time when often one parent was at home with the children[4,5]. Other family structures, although less common, include single-parent families and blended families that may consist of one biological parent and a new partner, as well as families where children share a household with both their parents and grandparents or live only with grandparents or other relatives[6]. Finally, for those two-parent working families, generally assistance with child care is required and may be provided by grandparents or other adults for long periods of the day, generating an opportunity for other adults to influence the child's life[7].

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Family structure and its effects on child well-being have been investigated in previous studies. Some have shown that the number of siblings living in the house is associated not only with the physical development[8] of children but also with their cognitive and educational progress[9,10]. Other studies have demonstrated that the child's psychological profile is associated with the number and type of adults living in the household[11,12]. Family is also a fundamental source of social learning: the environment in which children develop their personality, assuming attitudes of those whom they live with. Parents therefore become role models in the adoption and maintenance of health-promoting behaviours in children, including food choices[13] and physical activity[14], both factors possibly influencing child adiposity and currently of great interest due to the high prevalence of childhood obesity[15].

If 'adults' may impact food choices and lifestyle attitudes of children, it is conceivable that the family structure could play an important role in the pathogenesis of obesity in children and adolescents. However, despite the increase in childhood obesity in developed countries, only a few studies have focused their attention on the structure of the family and the associated weight status in children. The relationships between only child status and overweight were recently investigated by our group in the European cohort of children participating in the IDEFICS (Identification and prevention of dietary- and lifestyle-induced health effects in children and infants) baseline examination[16]. That study demonstrated that children without siblings (only children) show higher prevalence of overweight than their peers with siblings and that the longer the child remains an only child in the household the stronger is the association[16]. However, other aspects of family structure, such as the number and type of cohabiting adults, were not considered.

The objective of the present study was to re-examine the IDEFICS population 2 years later[16] to evaluate: (i) whether an association exists with the number and type of cohabiting adults; and (ii) whether a linear, exposure-dependent, association exists between child adiposity and the number of siblings. Further, the present analysis longitudinally (2 years) evaluated the changes in anthropometric indices and incidence of overweight/obesity in normal-weight children at baseline by number of siblings and cohabiting adults.

Methods

Design

The IDEFICS Project is a multilevel epidemiological study, funded within the Sixth EU Framework Programme, aiming to investigate nutritional and lifestyle factors affecting health status in children. The survey was carried out in eight European countries (Italy, Belgium, Cyprus, Estonia, Germany, Hungary, Spain and Sweden) and involved at baseline 16 224 children, recruited through schools and kindergartens, who fulfilled the inclusion criteria of the IDEFICS study[17]. The baseline survey (T0) was the starting point of the cohort study aimed to prospectively evaluate the role of the factors assessed at baseline on the development of overweight/obesity over time and to assess the feasibility, effectiveness and sustainability of a community-oriented intervention programme. Comparable intervention and control regions were selected in each country. In the intervention regions, a coherent set of intervention modules was implemented, focusing on diet, physical activity and stress-coping capacity[18]. A second survey (T1), synchronized with the baseline to account as much as possible for seasonal variation, reassessed the children 2 years (±1 month) later.

Parents or legal guardians were asked, both at the baseline and the follow-up examinations, to sign a written informed consent that offered the opportunity to participate in the whole programme or in selected modules of it. The study protocol was approved by the local ethics committee in each participating country.

Population

Cross-sectional analysis

The study population described here was composed of 13 498 children (83 % of the baseline sample) who were examined in the follow-up of the IDEFICS study carried out between September 2009 and May 2010; the present analysis refers to 12 350 children (girls = 50 %; mean age = 7·8 (SD 1·9) years; mean BMI = 17·1 (SD 3·1) kg/m^2) after the exclusion of those children for whom a complete data set was not available (*n* 1148); the two groups were comparable for all variables of interest except parental education level, which was higher in participating children.

Longitudinal analysis

Out of the 12 350 children participating in the follow-up, 10 279 previously participated also in the baseline examination carried out in 2007–2008[16]. For the purpose of the present analysis, 5236 children (girls = 49 %; mean age = 5·9 (SD 1·8) years; mean BMI = 15·5 (SD 1·2) kg/m^2) were selected after exclusion of overweight/obese children at baseline (*n* 2424) and normal-weight children who had an incomplete data set (*n* 2619). The latter group (girls = 49 %; mean age = 6·0 (SD 1·7) years; mean BMI = 15·5 (SD 1·2) kg/m^2) did not differ significantly at baseline from normal-weight children included in the analysis.

Procedures

Children underwent a brief physical examination within the school premises during which anthropometric indices (weight, height, skinfold thicknesses and waist circumference) were measured. The children were weighed in light clothes and without shoes by means of an electronic balance (Tanita BC 420 SMA; Tanita Europe GmbH, Sindelfingen, Germany) to the nearest 0·1 kg. Height was measured, without shoes, with a calibrated stadiometer (SECA 225; Seca, Birmingham, UK) with an approximation of 0·1 cm. Skinfold thickness was measured twice on the right side of the body with a skinfold calliper (Holtain Ltd, Crymych, UK; range 0–40 mm) to the nearest 0·2 mm. Tricipital (halfway between the acromion and the olecranon process at the back of the arm) and subscapular (about 2 cm below the tip of the scapula, at an angle of 45° to the lateral side of the body) skinfold thicknesses were measured in all participants. Waist circumference was measured midway between the superior iliac crest and the costal margin, using an anelastic tape (SECA 200), precision 0·1 cm, with the child in standing position. The procedures for anthropometric measurements were carefully standardized across participating centres[19].

Personal and familial medical history, socio-economic and demographic characteristics were assessed by means of a self-administered parental questionnaire (PQ)[20] filled in at home by parents and checked for inconsistencies at the time of the visit. Socio-economic status was assessed by parental education. To facilitate cross-country comparisons, the educational level was categorized according to the International Standard Classification of Education (ISCED)[21] into low (ISCED levels 1 and 2), medium (ISCED levels 3 and 4) and high (ISCED level 5) educational attainment.

The above described procedures were identical at the baseline and the follow-up survey.

Family structure

Family structure was investigated by means of the PQ by two components: (i) the number and type of cohabiting adults; and (ii) the number of cohabiting siblings. The number and type of cohabiting adults in the family was assessed based on the question 'Who does your child live with most of the time?' This information was categorized as follows: (i) with two biological parents; (ii) with one biological parent; (iii) with one parent and his/her new partner; (iv) half of the time with his/her mother and the other half with his/her father; (v) with grandparents; and (vi) with other adults.

The second component of the family structure was extracted from the question asking parents to indicate how many other children live with their child. Total number of siblings was calculated by summing the number of younger siblings, the number of older siblings and those of the same age. Sibling exposure was categorized into four subgroups: (i) only child; (ii) 1 sibling; (iii) 2 siblings; and (iv) >2 siblings.

Outcomes

Study outcome measures included: (i) waist-to-height ratio[22] (WHtR); (ii) the sum of tricipital and subscapular skinfold thicknesses (SST); (iii) age- and sex-specific BMI

Table 1 Characteristics of the sample according to the number and type of cohabiting adults: 12 350 children from eight European countries participating in the IDEFICS (Identification and prevention of dietary and lifestyle-induced health effects in children and infants) study

	Both parents (*n* 9537)		Mother or father (*n* 1786)		One parent and new partner (*n* 475)		50 % mother, 50 % father (*n* 238)		Grandparents (*n* 124)		Other (*n* 190)		
	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	*P*
Age (years)	7·8	7·7, 7·8	8·0[a]	7·9, 8·1	8·5[a,b]	8·3, 8·6	8·2[a]	7·9, 8·4	7·9	7·6, 8·3	7·9[c]	7·7, 8·2	<0·001
Boys (%)	49·9		50·4		45·9		49·6		50·8		46·8		0·553
Birth weight (g)	3347	3335, 3358	3252[a,c,d]	3324, 3280	3366	3312, 3420	3382	3303, 3460	3264	3175, 3352	3283	3187, 3378	<0·001
Height (cm)	128·4	128·1, 128·6	129·3[a,c]	128·8, 129·9	132·1[a]	131·1, 133·2	130·3	128·7, 131·9	129·2	126·9, 131·4	130·2	128·4, 132·1	<0·001
Weight (kg)	28·7	28·5, 28·9	30·3[a]	29·9, 30·8	30·2[a]	29·5, 31·1	29·3[e]	28·1, 30·4	32·4[a]	30·3, 34·4	30·4	28·8, 32·0	<0·001
WC (cm)	58·2	58·0, 58·3	60·0[a,e]	59·6, 60·4	59·0[e]	58·2, 59·6	58·6[e]	57·6, 59·6	63·0[a]	61·0, 64·9	59·5[e]	58·0, 61·0	<0·001
SST (mm)	20·6	20·4, 20·8	22·6[a,c,e]	22·1, 23·1	20·6[e]	19·7, 21·4	20·6[e]	19·3, 21·8	25·8[a]	23·3, 28·3	22·3	20·6, 24·0	<0·001
Ow/Ob (%)	21·9		29·7		17·5		20·6		41·9		26·8		<0·001
Home meal frequency (%)	77·2		78·2		72·1		75·3		78·6		70·9		<0·001
Practice of sport (%)	61·2		51·8		56·9		63·2		44·2		47·3		<0·001
Parental education													
Low (%)	60·2		29·9		4·2		0·9		2·2		2·5		<0·001
Medium (%)	75·5		14·8		4·9		2·1		1·1		1·7		<0·001
High (%)	82·9		10·8		2·5		1·9		0·7		1·2		<0·001
Parental overweight (%)	72·8		79·9		70·9		66·7		83·5		82·6		<0·001

WC, waist circumference; SST, sum of skinfold thicknesses; Ow/Ob, overweight or obesity.
Data are presented as means and 95 % confidence intervals or frequency, as appropriate.
Multiple comparisons (one-way ANOVA with Bonferroni's *post hoc* correction): [a]$P<0·05$ *v.* both parents; [b]$P<0·05$ *v.* mother or father; [c]$P<0·05$ *v.* one parent and new partner; [d]$P<0·05$ *v.* 50 % mother, 50 % father; [e]$P<0·05$ *v.* grandparents.

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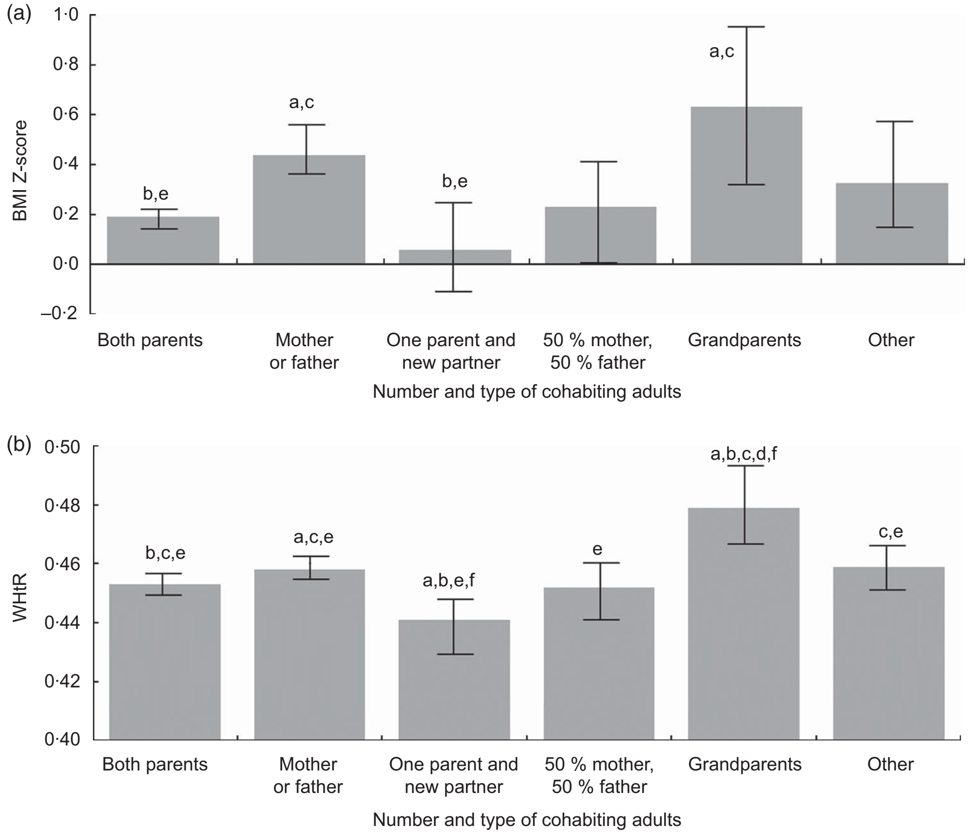

Fig. 1 (a) BMI Z-score and (b) waist-to-height ratio (WHtR) according to number and type of cohabiting adults (both parents: *n* 6729; mother or father: *n* 693; one parent and new partner: *n* 241; 50 % mother, 50 % father: *n* 141; grandparents: *n* 55; other: *n* 87) among 12 350 children from eight European countries participating in the IDEFICS (Identification and prevention of dietary and lifestyle-induced health effects in children and infants) study. Data (cross-sectional analysis) are expressed as means with their 95 % confidence intervals shown by vertical bars and are adjusted for age, sex, birth weight, home meal frequency, practice of sport by the child, parental education, parental adiposity, number of siblings, survey centre and intervention/control area. Multiple comparisons (ANCOVA with Bonferroni's *post hoc* correction): $^{a}P<0·05$ *v.* both parents; $^{b}P<0·05$ *v.* mother or father; $^{c}P<0·05$ *v.* one parent and new partner; $^{d}P<0·05$ *v.* 50 % mother, 50 % father; $^{e}P<0·05$ *v.* grandparents

Z-score calculated using the US Centers for Disease Control and Prevention 2000 (CDC) reference data[23]; and (iv) prevalence (or incidence in the longitudinal analysis) of overweight/obesity defined according to the standard criteria adopted by the International Obesity Task Force[24].

For the purposes of the longitudinal analysis, in addition to the incidence of overweight/obesity, 2-year BMI and BMI *Z*-score changes from baseline (ΔBMI and ΔBMI *Z*-score, respectively) were measured as outcome variables.

Confounders

Potential confounders, as estimated at the follow-up examination, included socio-economic and biological factors for both the children and their parents. Child factors were: sex, age, birth weight, practice of sport and home meal frequency. The child's birth weight was reported (in grams) by parents. The practice of sport was evaluated by the dichotomous variable 'child member in sports club' (y/n). The variable 'home meal relative frequency' was expressed as a percentage and indicated the frequency of meals that the children consumed at home with the family. Parental factors included: weight, height and education. Weight, height and education level of parents were self-reported in the PQ. Weight (in kilograms) and height (in metres) were used to calculate parental BMI (kg/m^2); parental overweight status was defined as the occurrence of BMI ≥25 kg/m^2 in none or in at least one parent (coded as 0 and 1, respectively). Finally, conditions associated with the study design, i.e. the survey centre and the possible effect of the intervention, were considered as possible confounders.

Statistical analysis

All analyses were performed using PASW Statistics version 18·0. Statistical significance was accepted for $P<0·05$. Data were expressed as mean and 95 % confidence interval or frequency, as appropriate. ANCOVA (*P* for trend for number of siblings as exposure factor) with *post hoc* analysis for multiple comparisons was used, for either the cross-sectional or the longitudinal study, to

Table 2 Characteristics of the sample according to the number of siblings: 12 350 children from eight European countries participating in the IDEFICS (Identification and prevention of dietary and lifestyle-induced health effects in children and infants) study

	Only child (*n* 2044)		1 sibling (*n* 6789)		2 siblings (*n* 2671)		>2 siblings (*n* 846)		
	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	*P* for trend
Age (years)	7·6	7·5, 7·7	7·8[a,b,d]	7·8, 7·9	8·0[a]	7·9, 8·0	8·1[a]	8·0, 8·2	<0·001
Boys (%)	50·2		49·8		48·6		51·2		0·427
Birth weight (g)	3316	3290, 3342	3336	3323, 3350	3345	3322, 3367	3318	3277, 3359	0·322
Height (cm)	128·4	127·8, 128·9	128·7	128·4, 129·0	129·1	128·6, 129·6	128·7	128·0, 129·6	0·275
Weight (kg)	29·4	29·0, 29·8	29·0	28·8, 29·2	29·0	28·7, 29·4	28·7	28·1, 29·4	0·292
WC (cm)	59·0	58·6, 59·4	58·5	58·3, 58·7	58·5	58·1, 58·8	58·4	57·8, 59·0	0·060
SST (mm)	22·3	21·8, 22·8	20·9[a,d]	20·7, 21·2	20·3[a]	19·9, 20·7	19·7[a]	19·0, 20·4	<0·001
Ow/Ob (%)	27·5		23·2		20·4		20·3		<0·001
Home meal frequency (%)	74·6		77·8		76·6		77·7		<0·001
Practice of sport (%)	60·1		61·0		57·5		48·3		<0·001
Parental education									
Low (%)	18·9		45·5		22·8		12·8		<0·001
Medium (%)	19·0		55·0		20·2		5·9		<0·001
High (%)	12·9		57·3		23·2		6·6		<0·001
Parental overweight (%)	74·8		72·5		74·3		77·4		0·014

WC, waist circumference; SST, sum of skinfold thicknesses; Ow/Ob, overweight or obesity.
Data are presented as means and 95 % confidence intervals or frequency, as appropriate.
Multiple comparisons (one-way ANOVA (*P* for trend) with Bonferroni's *post hoc* correction): [a]$P < 0·05$ *v.* only child; [b]$P < 0·05$ *v.* 1 sibling; [c]$P < 0·05$ *v.* 2 siblings; [d]$P < 0·05$ *v.* >2 siblings.

examine the relationship between family structure and study outcomes controlling for possible confounders: child sex, age, birth weight, home meal frequency and practice of sport, parental overweight, parental education, intervention/control area and survey centre. Additionally, the analysis for cohabiting adults was further adjusted for the number of siblings and the analysis for the number of siblings for cohabiting adults.

The risk of incident cases of overweight/obesity at the follow-up in normal-weight children at baseline by either the number of siblings or cohabiting adults was assessed by logistic regression analysis, controlling for age, sex, birth weight, home meal frequency, practice of sport by the child, parental adiposity, parental education, survey centre, intervention/control area and number of cohabiting adults or number of siblings, as appropriate.

Results

Cross-sectional analysis

Cohabiting adults

Characteristics of participants according to the number and type of cohabiting adults are shown in Table 1. The majority of children lived with both parents. Anthropometric indices (weight, height, waist and SST), age, practice of sport, parental education, home meal frequency and parental overweight were significantly different among the six family-structure categories. In particular, controlling for age, sex, birth weight, practice of sport by the child, parental education, parental adiposity, number of siblings, home meal frequency, intervention/control area and survey centre, children who lived with grandparents had significantly greater BMI *Z*-scores (Fig. 1(a), $P < 0·001$) than either children living with both parents or those living with one parent and new partner. The WHtR for children who lived with grandparents was significantly higher (Fig. 1(b), $P < 0·001$) than that for children with a different family structure. Finally, children living with only one parent showed significantly higher BMI *Z*-scores ($P < 0·001$) than those living with both parents. Children living with one parent and new partner showed the lowest BMI *Z*-scores (Fig. 1(a)) and WHtR (Fig. 1(b)) among groups.

Number of siblings

Table 2 describes the characteristics of the participating children according to the number of siblings living in the same household. There was no significant difference between groups for child sex, weight, height or birth weight. An inverse, linear, statistically significant (*P* for trend $< 0·001$) association was found between the number of siblings living in the same household and adiposity indices, i.e. the higher the number of siblings the lower the BMI *Z*-score (Fig. 2(a)) and WHtR (Fig. 2(b)). The association was independent of age, sex, birth weight,

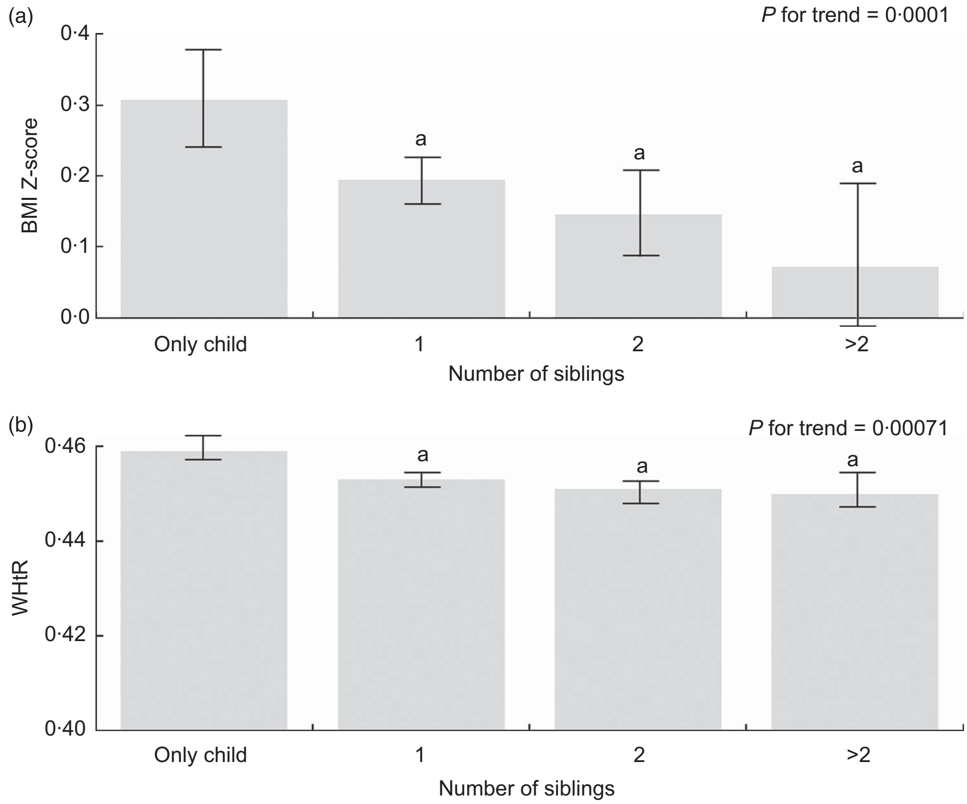

Fig. 2 (a) BMI Z-score and (b) waist-to-height ratio (WHtR) according to number of siblings (only child: *n* 1220; 1 sibling: *n* 4573; 2 siblings: *n* 1617; >2 siblings: *n* 428) among 12 350 children from eight European countries participating in the IDEFICS (Identification and prevention of dietary and lifestyle-induced health effects in children and infants) study. Data (cross-sectional analysis) are expressed as means with their 95 % confidence intervals shown by vertical bars and are adjusted for age, sex, birth weight, home meal frequency, practice of sport by the child, parental education, parental adiposity, number and type of cohabiting adults, survey centre and intervention/control area. Multiple comparisons (ANCOVA with Bonferroni's *post hoc* correction): (a) $^{a}P<0{\cdot}05$ *v.* only child; (b) $^{a}P<0{\cdot}005$ *v.* only child

home meal frequency, practice of sport by the child, parental education, parental adiposity, number and type of cohabiting adults, intervention/control area and survey centre. A similar pattern was observed for SST either as absolute values (Table 2) or *Z*-scores (data not shown), after adjustment for confounders.

Longitudinal analysis

Cohabiting adults

Table 3(a) shows the changes at follow-up in BMI and BMI *Z*-scores of the normal-weight children participating in the baseline survey, by number and type of cohabiting adults. After 2 years, significant differences in ΔBMI ($P<0{\cdot}001$) by cohabiting adults were observed; in particular, BMI increased significantly less in children living with one parent and new partner or with other cohabiting adults in comparison with children who lived with both parents or with those living with only one parent (mother or father), independently of possible confounders. The changes in BMI *Z*-score were not significantly different across subgroups (Table 3(a)). Controlling for covariates by logistic regression, the number of incident cases of overweight/obesity at follow-up was not significantly different across categories of cohabiting adults with the sole exception of children living with 'other adults' (Fig. 3(a), last column), in whom the risk was significantly reduced in comparison to children living with both parents.

Number of siblings

Table 3(b) depicts changes in anthropometric indices at 2-year follow-up in normal-weight children at baseline by number of siblings. Over the 2-year follow-up, BMI increased significantly less the higher the number of siblings living in the household (P for trend $<0{\cdot}001$, controlled for covariates). A similar trend was observed for ΔBMI *Z*-score (P for trend $=0{\cdot}027$). Logistic regression analysis – adjusted for age, sex, birth weight, home meal frequency, practice of sport by the child, parental adiposity, parental education, number of cohabiting adults, survey centre and intervention/control area – showed that the risk of developing overweight/obesity was inversely and significantly ($P<0{\cdot}001$) associated with the number of siblings living in the household (Fig. 3(b)).

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Table 3 Changes in anthropometric indices at 2-year follow-up in normal-weight children at baseline by (a) number and type cohabiting adults and (b) number of siblings: 5236 children from eight European countries participating in the IDEFICS (Identification and prevention of dietary and lifestyle-induced health effects in children and infants) study

(a)	Both parents (*n* 4607)		Mother or father (*n* 409)		One parent and new partner (*n* 104)		50 % mother, 50 % father (*n* 59)		Grandparents (*n* 21)		Other (*n* 36)		
	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	*P*
ΔBMI	0·55[c]	0·52, 0·59	0·71[a,c]	0·60, 0·82	0·25[a,b]	0·03, 0·46	0·62	0·33, 0·89	0·72	0·25, 1·19	0·14[a,b]	−0·22, 0·51	<0·001
ΔBMI *Z*-score	0·08	0·06, 0·09	0·15	0·08, 0·21	−0·03	−0·16, 0·10	0·10	−0·07, 0·28	0·15	−0·15, 0·45	−0·15	−0·38, 0·07	0·069

(b)	Only child (*n* 884)		1 sibling (*n* 3130)		2 siblings (*n* 987)		>2 siblings (*n* 235)		*P* for trend
	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	
ΔBMI	0·65[c,d]	0·58, 0·72	0·57	0·53, 0·60	0·48[a]	0·41, 0·55	0·45[a]	0·30, 0·59	<0·001
ΔBMI *Z*-score	0·11	0·07, 0·16	0·08	0·06, 0·11	0·04	0·03, 0·09	0·04	−0·05, 0·12	0·027

ΔBMI, change in BMI; ΔBMI *Z*-score, change in BMI *Z*-score.
Categories of number and type of cohabiting adults and number of siblings refer to follow-up.
Data are presented as means and 95 % confidence intervals and are adjusted for age, sex, birth weight, home meal frequency, practice of sport by the child, parental adiposity, parental education, number of siblings (in (a) only), number and type of cohabiting adults (in (b) only), survey centre and intervention/control area.
Multiple comparisons (ANCOVA (*P* for trend) with Bonferroni's *post hoc* correction): (a) [a]$P<0·01$ *v.* both parents; [b]$P<0·01$ *v.* mother or father; [c]$P<0·01$ *v.* one parent and new partner; (b) [a]$P<0·05$ *v.* only child; [c]$P<0·05$ *v.* 2 siblings; [d]$P<0·05$ *v.* >2 siblings.

Discussion

The present study demonstrated that family structure, as either the number and type of cohabiting adults or the number of siblings, is associated with the degree of adiposity in children.

Children living with a single parent tended to be heavier (cross-sectional analysis) or gain more weight (longitudinal analysis) than children living within other family structures. Single parents are more likely to suffer from a lack of quality time with their children and, in addition, might give less importance to their food choices, allowing them to eat high-energy foods[25–29]. In addition, single parents may have little time to play with their children or to encourage them to participate in physical activity[25].

On the other hand, at least in the cross-sectional analysis, child overweight appeared to be more common among children living with grandparents. Different reasons could explain our finding. It could be hypothesized that grandparents could be excessively indulgent to the whims of the children or, alternatively, they could favour sedentary lifestyles in children being less physically active themselves because of advanced age and consequent physical deficiencies. Moreover, it is quite common among grandparents to consider 'eating' as synonymous with well-being and they may thus encourage eating even in the absence of hunger[25,29]. The longitudinal analysis carried out in the IDEFICS sample did not confirm the results of the cross-sectional analysis; however, our longitudinal data cannot be considered as definitive because the sample of children in this family-structure category included in the longitudinal analysis was composed of only twenty-one participants, with a consequent loss of statistical power.

The present study also indicated that children living with one parent and his/her new partner were leaner, or, when prospectively analysed, tended to gain less weight over time than those living in the other family structures examined. The reason for this finding is not clear and no previous studies have investigated this issue. It is possible that children living in a new context, with different rules and habits, live a stressful situation[30] that may influence eating habits; however, further studies, more specifically designed to answer these questions, are requested. Similarly, caution should be used in the interpretation of findings referring to the cohabiting adults category indicated as 'other adults' because it is composed by miscellaneous conditions that makes it difficult to disentangle the effective familial component relevant for the observed association: the conclusions we could possibly draw from this finding are not specific but, in any case, it once again reinforces the importance of family structure for childhood obesity.

With regard to the number of siblings, in agreement with the results of the first analysis carried out in the IDEFICS

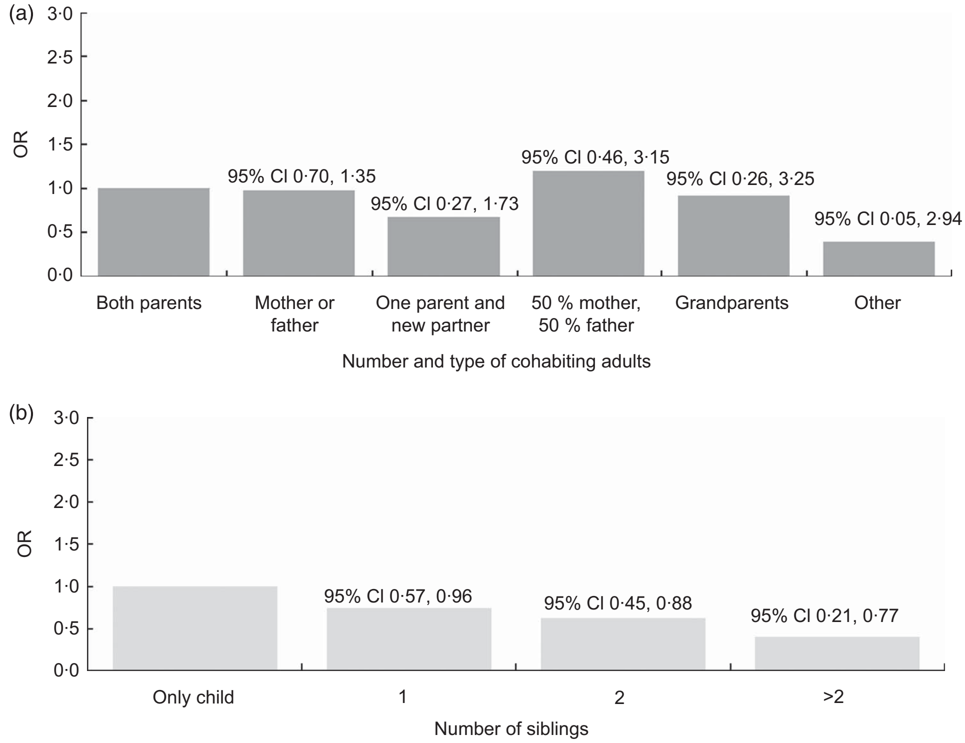

Fig. 3 Odds ratios and 95 % confidence intervals for overweight/obesity, defined according to the International Obesity Task Force age- and sex-specific cut-offs[24], according to (a) number and type of cohabiting adults (both parents: *n* 4607; mother or father: *n* 409; one parent and new partner: *n* 104; 50 % mother, 50 % father: *n* 59; grandparents: *n* 21; other: *n* 36) and (b) number of siblings (only child: *n* 884; 1 sibling: *n* 3130; 2 siblings: *n* 987; >2 siblings: *n* 235) among 5236 children from eight European countries participating in the IDEFICS (Identification and prevention of dietary and lifestyle-induced health effects in children and infants) study. Data (longitudinal analysis) are adjusted for age, sex, birth weight, practice of sport by the child, parental adiposity, parental education, home meal frequency, number of siblings (in (a) only), number and type of cohabiting adults (in (b) only), survey centre and intervention/control area

cohort at baseline[16], we confirmed that only children are more prone to develop obesity; but furthermore the present analysis additionally documented that a linear association existed, such that the higher the number of siblings living in the household, the lower the proportion of overweight/obese children. If only children usually receive excessive attention from parents[25] it follows that the higher the number of siblings, the lower the amount of time parents can spend with their children and, in some cases, also material resources in the household may be stretched[25]. The cross-sectional analysis demonstrated the occurrence of an association between number of siblings and adiposity in children, but no cause-and-effect conclusions can be drawn. In contrast, the longitudinal analysis additionally performed in our study sample suggested that both the incidence of overweight/obesity and the changes in BMI are significantly lower the fewer the number of siblings living in the household, thus supporting the hypothesis that a familial environment with a few siblings might predispose to the development of overweight in children. According to our findings, it is not just the condition of being an only child that is associated with an increased risk of overweight, but rather a linear 'dose–response' association exists between exposure and outcome.

One possible limitation of the present study is that, at the time the study was designed, we did not focus on the gender of siblings as a possible cofactor in the association between number of siblings and child adiposity. In principle, it is not expected that the gender of siblings would impact on the association observed; however, this issue certainly deserves further investigation. Whether gender of siblings would influence the association between number of siblings and child adiposity could be answered by specifically designing a study for this intent. Additionally, no information is available in the IDEFICS study on adiposity indices of siblings living in the same household. In both cases, the knowledge gap will possibly be covered by the collection of such information in the ongoing I.Family study (www.ifamilystudy.eu), which is a follow-up of the original IDEFICS cohort.

To the best of our knowledge, the present study is the first one investigating the association between family structure and childhood obesity in a very large population sample as well as the first providing longitudinal data on this association, thus providing, at least in part, new insights on possible cause-and-effect relationships. A further strength of the study is the sharp standardization of the procedures in this multi-centre study.

Specifically designed studies are needed to better understand the complex relationships between family structure and child adiposity. Nevertheless our findings provided a relevant piece of knowledge in better defining the family structure in which childhood obesity develops and identified novel components constituting the profile of risk for paediatric obesity.

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