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Family sociodemographic characteristics as correlates of children's breakfast habits and weight status in eight European countries. The ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project

Yannis Manios[1,*], George Moschonis[1], Odysseas Androutsos[1], Christina Filippou[1], Wendy Van Lippevelde[2], Froydis N Vik[3], Saskia J te Velde[4], Natasha Jan[5], Alain Dössegger[6], Elling Bere[3], Denes Molnar[7], Luis A Moreno[8], Mai JM Chinapaw[9], Ilse De Bourdeaudhuij[10] and Johannes Brug[4] on behalf of the ENERGY Consortium

[1]Department of Nutrition and Dietetics, Harokopio University, 70 El Venizelou Avenue, 17671 Kallithea, Athens, Greece: [2]Department of Public Health, Ghent University, Ghent, Belgium: [3]Department of Public Health, Sport and Nutrition, University of Agder, Kristiansand, Norway: [4]Department of Epidemiology and Biostatistics and EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, The Netherlands: [5]Slovenian Heart Foundation, Ljubljana, Slovenia: [6]Swiss Federal Institute of Sport, Magglingen, Switzerland: [7]Department of Paediatrics, University of Pecs, Pecs, Hungary: [8]GENUD (Growth, Exercise, Nutrition and Development) Research Group, EU Ciencias de la Salud, Universidad de Zaragoza, Zaragoza, Spain: [9]Department of Public and Occupational Health and EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, The Netherlands: [10]Department of Movement and Sport Sciences, Ghent University, Ghent, Belgium

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Abstract

Objective: The purpose of the present study was to investigate the associations of family sociodemographic characteristics with children's weight status and whether these potential associations are mediated by children's breakfast habits.

Design: A school-based survey among 10–12-year-old children was conducted in eight European countries. Children's weight and height were measured and breakfast habits and family sociodemographic characteristics were self-reported by 5444 children and their parents. International Obesity Task Force cut-off points were used to categorize children as overweight/obese or normal weight. Mediation analyses were used to test the potential mediating effect of children's breakfast consumption on the associations between family sociodemographic characteristics and children's overweight/obesity.

Setting: Schools in eight European countries participating in the ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project.

Subjects: Children aged 10–12 years and their parents (n 5444).

Results: Children's reported daily breakfast consumption varied from 56 % in Slovenia to 92 % in Spain on weekdays and from 79 % in Greece to 93 % in Norway on weekends. Children of native parents, with both parents employed and with at least one parent having more than 14 years of education were more likely to consume breakfast daily and less likely to be overweight/obese. Finally, mediation analyses revealed that the association of parental nationality and parental educational status with children's overweight/obesity was partially mediated by children's daily breakfast consumption.

Conclusions: The study shows that the lower likelihood of being overweight/obese among 10–12-year-old children of native background and higher parental educational status was partially mediated by children's daily breakfast consumption.

Keywords
Demographics
Children's breakfast consumption
Overweight
Obesity
Mediation analysis

Childhood overweight and obesity has increased at an alarming rate and reached epidemic proportions throughout the world over the last decades, although great regional differences have been detected[1–6]. Different earlier studies, as well as the first published reports from the ENERGY ('EuropeaN Energy balance Research to prevent excessive

*Corresponding author: Email manios@hua.gr

weight Gain among Youth') project, indicate that childhood overweight and obesity is significantly and substantially more prevalent among children from lower educated and ethnic minority parents, as well as in southern compared with northern European countries[7,8].

The increased prevalence of overweight and obesity among children and adolescents can mainly be attributed to certain behaviours related to diet and physical activity[9,10]. Literature on the association between eating patterns and overweight indicates that breakfast habits may be of importance[11]. The results of several cross-sectional studies across the world suggest that skipping breakfast is related to higher BMI and increased probability of being overweight/obese[6,12–15]. This finding is also supported by the ENERGY study data[16] and by prospective studies[17,18]. Despite the probable importance of breakfast consumption, breakfast skipping is common among children and adolescents[12,14,19,20]. Furthermore, breakfast habits adopted in childhood may track into adulthood[21,22]. Hence, the identification of those factors related to overweight/obesity in children and of the paths via which these associations occur, e.g. via breakfast habits, is important in order to design more effective, tailor-made interventions.

Children's eating habits are associated with socio-cultural, economic and physical environmental factors. Previous studies examining the association between socio-economic status (SES) and breakfast habits indicate that a child or adolescent living in a single-parent family[23] or in a family with low SES[17,23–25] is more likely to have irregular breakfast consumption. However, cross-country comparative data on the prevalence of breakfast consumption or skipping, as well as on the association of SES with breakfast habits in children, is limited in Europe[23]. In this context, the first results from the ENERGY project showed that children's mean weekly breakfast consumption frequency in Europe was 5·9 d/week, ranging from 5·1 in Slovenia to 6·7 in Spain[26], with no significant differences between boys and girls[8]. Regarding ethnic background (assessed either by language spoken at home or by country of birth of the parents), the findings from the ENERGY project showed a higher prevalence of breakfast skipping in non-native compared with native children[7]. These differences in breakfast habits among native and non-native children are possibly due to cultural differences regarding different dietary habits observed in families of different ethnic background[27]. Moreover, the fact that ethnic minority groups have higher rates of unhealthy behaviours might be due to their lower educational level[7,27]. These differences may also be attributed to non-native children's social and physical environment, since living in deprived environments or losing social context may prohibit children's breakfast consumption[7,28]. None the less, the question of whether children's breakfast consumption mediates the association between family sociodemographic characteristics and children's weight status has not yet been investigated. Such an investigation can help to explain socio-cultural differences in children's weight status and may provide entry points for interventions aiming to reduce socio-cultural inequalities in overweight and obesity.

Considering all of the above, the current study aimed to: (i) investigate the associations between certain family sociodemographic and parental characteristics (i.e. children's gender, family structure, parental nationality, occupational status, education) with children's breakfast consumption habits and overweight/obesity; (ii) examine the associations between children's breakfast consumption habits and overweight/obesity; and (iii) assess the potential mediating effect of children's daily breakfast consumption in the associations of family sociodemographic and parental characteristics with children's overweight/obesity. These three aims will be jointly tested using mediation analyses.

Methods

Study design and participants

The rationale and organization of the ENERGY project[29] and a comprehensive description of the design, procedures and methodology of the ENERGY school-based survey[30] are published elsewhere. Seven countries from the ENERGY Consortium, namely Belgium, Greece, Hungary, the Netherlands, Norway, Slovenia and Spain, participated in the cross-sectional survey. Switzerland joined the Consortium in a later phase[31]. The school-based survey of the ENERGY project was carried out among 10- to 12-year-old children and their parents. The recruitment and data collection took place from March to July 2010 (Belgium, Greece, Hungary, the Netherlands, Norway, Slovenia and Spain) and between June and December 2010 (Switzerland). These countries were selected since they provide variation across regions in Europe and thus variation in potential obesogenic behaviours and prevalence of overweight and obesity. All participating countries obtained ethical clearance from the relevant ethical committees and ministries. The project adhered to the Helsinki Declaration and the Convention on Human Rights and Biomedicine of the Council of Europe.

Sampling was national in Greece, Hungary, the Netherlands and Slovenia. In Spain, schools in the region of Aragón were selected; Belgium selected schools from Flanders, Norway selected schools from the southern regions of the country, and Switzerland from the German-speaking part of the country[30]. The sampling of schools was random, multistage and stratified by degree of urbanization in the regions under study. More details on the sampling procedure are presented elsewhere[30]. A school recruitment letter was sent to the headmaster or principal of the participating schools, followed by a personal telephone call. Following the school's approval for participation in the study, parents received a letter explaining the study purpose and were asked for written consent for their child's and own participation. Detailed information on response rates at school, child and parent level has been

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reported elsewhere[8]. A total of 199 schools participated, with 7915 children (children's response rate 60 %) and 6512 parents (parents' response rate 55 %) completing questionnaires across the eight countries.

Data collection

Measurements in all countries were conducted according to a standardized protocol[30]. The study entailed anthropometric measurements, a child questionnaire and a parent questionnaire. These questionnaires were used to measure children's energy balance-related behaviours and potential individual, sociodemographic and environmental correlates of these behaviours. The data collection protocol and survey questionnaires for the ENERGY cross-sectional survey are available online (http://projectenergy.eu). Detailed information regarding the development, validity and reliability of the child questionnaire is published elsewhere[30,32]. Children completed the questionnaires addressed to them during school time. Children also received the parent questionnaire in a closed envelope to take home for completion by one of the parents.

Anthropometric measurements

Body height and weight measurements were conducted by trained research assistants. Children were weighed in light clothing without shoes using a Seca digital scale (Seca Alpha, model 861, Hamburg, Germany) with an accuracy of 0·1 kg. Body height was measured to the nearest 0·1 cm using a commercial stadiometer (Leicester Height Measure, Invicta Plastics Ltd, Oadby, UK) with children keeping their shoulders in a relaxed position, their arms hanging freely and their head aligned in the Frankfort horizontal plane. Two readings of each measurement were obtained. If the two readings differed more than 1 % then a third measurement was taken. BMI was calculated and the International Obesity Task Force (IOTF) cut-off points[33,34] were used to categorize participants into a dichotomous weight status variable, i.e. normal weight (also including underweight) and overweight/obese.

Breakfast consumption

Children's breakfast consumption was assessed by two questions asking children on how many schooldays and how many weekend days per week they normally had breakfast. Breakfast frequency per week was calculated by adding up the answers of the two questions. Then, children were divided in two categories: (i) those with daily breakfast consumption (DBC); and (ii) those skipping breakfast at least once during weekdays (i.e. at least once out of five days) and/or weekends (i.e. at least once out of two days).

Family sociodemographic characteristics

Data on family sociodemographic characteristics obtained in the present study included parental educational status, employment status, family structure and nationality. The educational status was categorized as: 'both parents <14 years of education' and 'at least one parent ≥ 14 years of education', distinguishing families with at least one caregiver who had completed medium or higher vocational, college or university training from other families. The parental employment status was categorized as: 'at least one unemployed' and 'both employed'. Family structure was divided into two categories: i.e. single- and dual-parent family. Regarding parental nationality, parents were further categorized as native and non-native based on their country of birth. A dichotomous variable was created, according to the definition of foreign ethnic background used by Statistics Netherlands, distinguishing children for whom both parents were born in the country of administration (native) from children for whom at least one parent was born in another country (non-native).

Statistical analyses

Categorical variables are summarized as relative frequencies (%), while continuous variables are presented as mean and standard deviation. Unadjusted associations between categorical variables were assessed using the χ^2 test.

Multilevel logistic regression analyses were performed for the overall sample, with children nested within classes, nested within schools (three-level random intercept model) in order to assess the statistical significance of the associations between family sociodemographic characteristics, children's breakfast consumption and children's overweight/obesity. More specifically, three multiple logistic regression models were applied to examine the simultaneous associations of all demographic characteristics (independent variables) with the probability of children's DBC and childhood overweight/obesity (dependent variables). The results are presented as odds ratios and 95 % confidence intervals.

In addition, mediation of the associations of family sociodemographic characteristics with children's weight status by children's breakfast consumption was tested using a path analytic approach as outlined by MacKinnon *et al.*[35,36], although the cross-sectional design of the present study is not optimal for this kind of analysis. First, associations between each demographic characteristic and children's overweight/obesity were examined (total association, path *c*). Second, associations of each demographic characteristic with children's breakfast consumption (potential mediator) were studied (Action Theory test, path *a*). Third, the association between breakfast consumption of the children (mediator) and children's overweight/obesity was examined (Conceptual Theory Test, path *b*) adjusted for the demographic variables. Finally, the associations between each demographic variable with children's overweight/obesity adjusted for children's breakfast consumption were estimated (direct path, path *c*′; Fig. 1).

All coefficients (i.e. *a*, *b*, *c* and *c*′) obtained from the corresponding three-level random-intercept logistic regression model were standardized as recommended by

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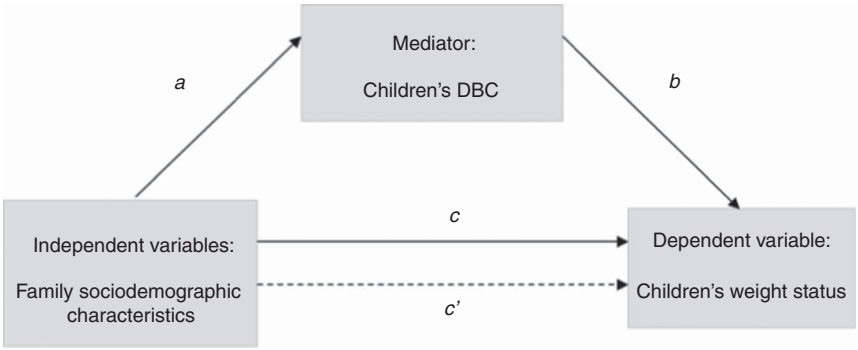

Fig. 1 Schematic presentation of the mediation models examined in the present study (DBC, daily breakfast consumption)

MacKinnon and Dwyer because the outcome variable (overweight/obesity) and the mediator (children's breakfast consumption) are dichotomous[37]. The mediated effect ($a \times b$) was calculated as the product of standardized coefficients a and b (indirect effect)[35]. This was calculated only when both path a and path b were significant. The statistical significance and the 95 % confidence interval of the mediated effects were estimated using Preacher and Hayes' bootstrapping method[38]. In addition, the proportion mediated was calculated by dividing the indirect effect by the sum of the direct effect (standardized c' coefficient) and the indirect effect ($a \times b$). This was calculated only in the case of a significant total association (path c) to prevent unreliable and uninterruptable proportions.

All reported P values were based on two-sided tests. The level of statistical significance was set at $P < 0{\cdot}05$. The statistical software package STATA 12·0 was used for all statistical analyses. In particular, the command xtmelogit was used to apply the three-level random-intercept models.

Results

Descriptive data

In total, full data on the variables under investigation were available for 5444 children and their parents who filled in the relevant questionnaires in the eight participating countries. The population under study consisted of children and their parents having full data in all variables needed to test the research hypothesis (i.e. full anthropometric data and full data on children's breakfast habits and family sociodemographic characteristics collected from questionnaires completed by children and their parents, respectively). In almost all countries participating in the ENERGY project full data were collected from the majority of children and their parents. More specifically, the response rates, taking into account these rates at the school, child and parent levels, ranged from 33·4 % in the Netherlands to 83·0 % in Spain. With the exception of the Netherlands where the low willingness to participate at the school level led to a relatively low response rate[8], the relevant rates were not found to differentiate significantly among the other seven countries. Descriptive data on sociodemographic variables are presented for the total sample and by country in Table 1.

Family sociodemographic characteristics and children's breakfast consumption

As presented in Table 2, overall 74 % of school-aged children reported DBC on weekdays and 87 % on weekends. DBC on weekdays varied from 56 % in Slovenia to 92 % in Spain and on weekends from 79 % in Greece to 93 % in Norway. The rates of DBC were higher on weekends than on weekdays in all participating countries. The highest DBC rates were observed in the Netherlands, Norway and Spain.

Moreover, in the total sample, the present study showed that DBC was significantly higher among children whose parents were native, were both employed and had higher educational status. As indicated in Table 2, depending on the country, respective significant differences in the prevalence of DBC on weekdays and/or on weekends between children with different family sociodemographic characteristics were almost consistently observed in Greece, Slovenia and Spain, while no significant differences were observed for Belgium, the Netherlands and Norway.

Associations of family sociodemographic characteristics with children's breakfast consumption habits and children's weight status

Multiple logistic regression analyses presented in Table 3 showed that boys (OR = 1·25, 95 % CI 1·10, 1·43), children of native background (OR = 1·53, 95 % CI 1·30, 1·80), with both parents employed (OR = 1·20, 95 % CI 1·00, 1·43) and with at least one parent having more than 14 years of education (OR = 1·48, 95 % CI 1·29, 1·69) were more likely to eat breakfast on weekdays, compared with their counterparts. On weekends boys were less likely than girls to have breakfast (OR = 0·70, 95 % CI 0·60, 0·83), but children of native background (OR = 1·40, 95 % CI 1·15, 1·71), with both of their parents employed (OR = 1·58, 95 % CI 1·31, 1·89) and with at least one parent having more than 14 years of education (OR = 1·33, 95 % CI 1·12,

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Table 1 Family sociodemographic and parental characteristics for a cohort of 10- to 12-year-old children in Europe presented by country; the ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project, 2010

Characteristic	Total (*n* 5444)	Belgium (*n* 646)	Greece (*n* 840)	Hungary (*n* 741)	Netherlands (*n* 320)	Norway (*n* 686)	Slovenia (*n* 838)	Spain (*n* 847)	Switzerland (*n* 526)
Gender (% boys)	46·7	44·6	45·1	43·0	48·8	47·5	47·1	48·6	51·0
Children's age (years)									
Mean	11·6	11·5	11·3	12·2	11·6	12·0	11·4	11·4	11·6
SD	0·7	0·7	0·6	0·6	0·7	0·7	0·6	0·6	0·8
Family structure (%)									
Single-parent family	5·6	7·4	4·5	4·3	5·3	2·0	3·1	4·7	16·7
Dual-parent family	94·4	92·6	95·5	95·7	94·7	98·0	96·9	95·3	83·3
Parental occupational status (%)									
At least one unemployed	22·3	14·1	30·8	23·9	25·6	10·1	13·1	27·9	36·1
Both employed	77·7	85·9	69·2	76·1	74·4	89·9	86·9	72·1	63·9

Descriptive data on parental nationality and parental education can be found elsewhere[7,8].

Table 2 Percentage of 10- to 12-year-old children in Europe with daily breakfast consumption on weekdays and on weekends presented by family sociodemographic and parental characteristics and country; the ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project, 2010

Characteristic	Total (*n* 5444)	Belgium (*n* 646)	Greece (*n* 840)	Hungary (*n* 741)	Netherlands (*n* 320)	Norway (*n* 686)	Slovenia (*n* 838)	Spain (*n* 847)	Switzerland (*n* 526)
Total									
Weekdays	74·4	77·4	63·8	65·6	91·9	85·9	55·7	92·3	75·5
Weekends	87·3	87·9	78·7	86·5	90·9	92·7	87·0	92·1	85·4
Gender									
Girls									
Weekdays	72·7[a]	75·1	61·8	61·1[a]	93·3	85·6	51·9[a]	92·6	78·3
Weekends	89·2[b]	89·1	81·3[b]	87·2	92·7	93·1	89·6[b]	94·7[b]	88·8[b]
Boys									
Weekdays	76·4[a]	80·2	66·2	71·5[a]	90·4	86·2	60·0[a]	92·0	72·8
Weekends	85·3[b]	86·5	75·5[b]	85·6	89·1	92·3	84·1[b]	89·3[b]	82·1[b]
Parental nationality									
Non-native parents									
Weekdays	64·7[a]	71·7	58·5[a]	59·0	86·7	81·0	46·9[a]	72·8[a]	70·1[a]
Weekends	82·1[b]	93·5	75·9	82·1	84·4	88·6	82·1[b]	85·2[b]	82·1
Native parents									
Weekdays	76·4[a]	77·8	66·1[a]	66·0	92·7	86·7	57·8[a]	94·4[a]	78·4[a]
Weekends	88·4[b]	87·5	79·9	86·8	92·0	93·5	88·2[b]	92·8[b]	87·1
Family structure									
Single-parent family									
Weekdays	65·0	68·8	52·6	53·1	82·4	78·6	26·9[a]	87·5	68·2
Weekends	86·1	93·8	71·1	84·4	82·4	92·9	92·3	90·0	85·2
Dual-parent family									
Weekdays	75·0	78·1	64·3	66·1	92·4	86·0	56·7[a]	92·6	76·9
Weekends	87·4	87·5	79·1	86·6	91·4	92·7	86·8	92·2	85·4
Parental occupational status									
At least one parent unemployed									
Weekdays	71·3[a]	73·6	57·1[a]	62·7	89·0	82·6	55·5	88·6[a]	73·7
Weekends	81·9[b]	82·4	73·0[b]	79·1[b]	90·2	89·9	76·4[b]	90·3	82·6
Both parents employed									
Weekdays	75·3[a]	78·0	66·8[a]	66·5	92·9	86·2	55·8	93·8[a]	76·5
Weekends	88·9[b]	88·8	81·2[b]	88·8[b]	91·2	93·0	88·6[b]	92·8	86·9
Parental education									
Both parents < 14 years of education									
Weekdays	66·6[a]	72·0	61·3	64·0	92·5	79·2[a]	48·6[a]	87·9[a]	71·5[a]
Weekends	83·4[b]	75·0[b]	76·9	88·1	89·6	92·9	81·8[b]	87·3[b]	83·3
At least one parent ≥ 14 years of education									
Weekdays	78·6[a]	78·4	66·1	66·7	91·7	88·0[a]	61·1[a]	93·4[a]	81·3[a]
Weekends	89·4[b]	90·3[b]	80·3	85·3	91·3	92·7	91·0[b]	93·3[b]	88·3

[a,b]Percentages with the same superscript letter differentiate statistically significantly within each column (more specifically within each category of socio-demographic and parental characteristics presented in the table; $P < 0·05$ derived from χ^2 test).

1·58) were more likely to eat breakfast, compared with their counterparts. Boys were more like to be overweight/obese (OR = 1·38, 95 % CI 1·20, 1·58) than girls, but children with both their parents employed (OR = 0·81, 95 % CI 0·69, 0·96) and children with at least one parent having more than 14 years of education (OR = 0·82, 95 % CI 0·71, 0·96) were less likely to be overweight/obese, compared with their counterparts.

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Table 3 Association between selected demographic characteristics and children's breakfast consumption on weekdays and weekends and between selected demographic characteristics and overweight/obesity in 10- to 12-year-old children in Europe; the ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project, 2010. Results from multilevel multiple logistic regression*

	Dependent variable					
	DBC on weekdays *v.* skipping breakfast on weekdays		DBC on weekends *v.* skipping breakfast on weekends		Overweight/obesity *v.* normal weight	
Independent variable	OR*	95 % CI	OR*	95 % CI	OR*	95 % CI
Gender						
Girls	1·00		1·00		1·00	
Boys	**1·25**	**1·10, 1·43**	**0·70**	**0·60, 0·83**	**1·38**	**1·20, 1·58**
Parental nationality						
Non-native	1·00		1·00		1·00	
Native	**1·53**	**1·30, 1·80**	**1·40**	**1·15, 1·71**	0·97	0·80, 1·17
Family structure						
Single-parent family	1·00		1·00		1·00	
Dual-parent family	1·26	0·98, 1·66	0·91	0·64, 1·28	0·94	0·67, 1·31
Parental occupational status						
At least one unemployed	1·00		1·00		1·00	
Both employed	**1·20**	**1·00, 1·43**	**1·58**	**1·31, 1·89**	**0·81**	**0·69, 0·96**
Parental educational level						
Both parents <14 years of education	1·00		1·00		1·00	
At least one parent ≥14 years of education	**1·48**	**1·29, 1·69**	**1·33**	**1·12, 1·58**	**0·82**	**0·71, 0·96**

DBC, daily breakfast consumption.
*Each one of the three multiple logistic regression analyses included and was thus adjusted for all independent variables presented in the table. Significant associations are indicated in bold font.

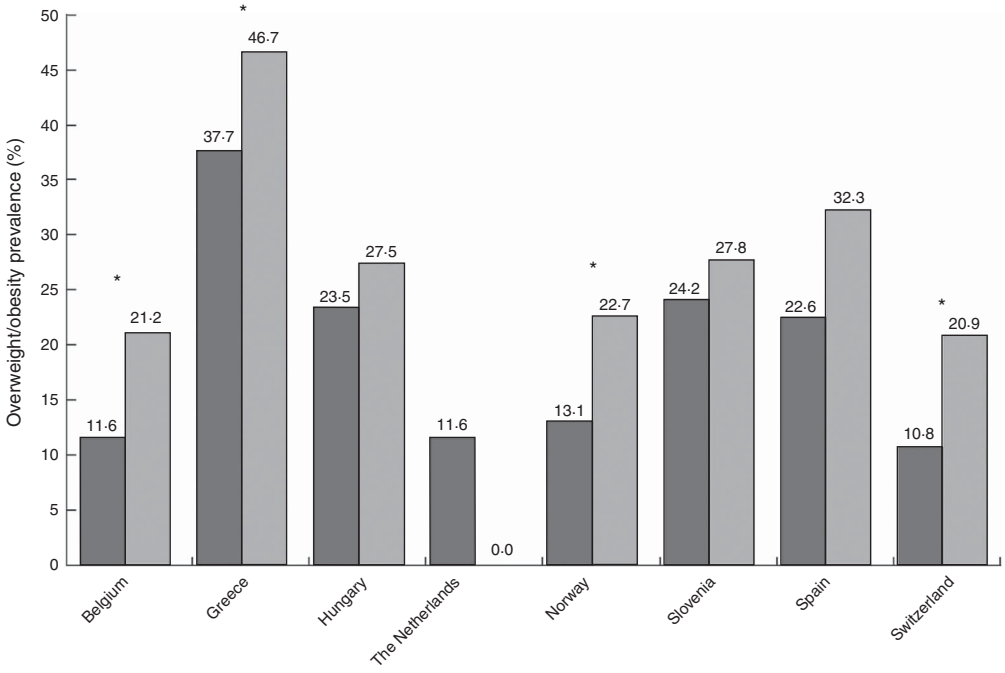

Fig. 2 Prevalence of overweight/obesity in 10- to 12-year-old children in Europe, according to their breakfast consumption habits on weekdays (■, daily breakfast consumption (DBC) on weekdays; □, skips breakfast on weekdays); the ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project, 2010. *$P < 0·05$ for the comparison between DBC and breakfast skipping categories

Prevalence of overweight/obesity by breakfast consumption habits

The prevalence of overweight/obesity was significantly higher among children skipping breakfast compared with those with DBC on weekdays in four countries (i.e. Belgium, Greece, Norway and Switzerland; Fig. 2) and on weekends in two countries (i.e. Norway and Spain; Fig. 3).

Mediation analyses

Table 4 summarizes the results derived from the mediation analyses. Regarding indirect associations (path *c*), gender,

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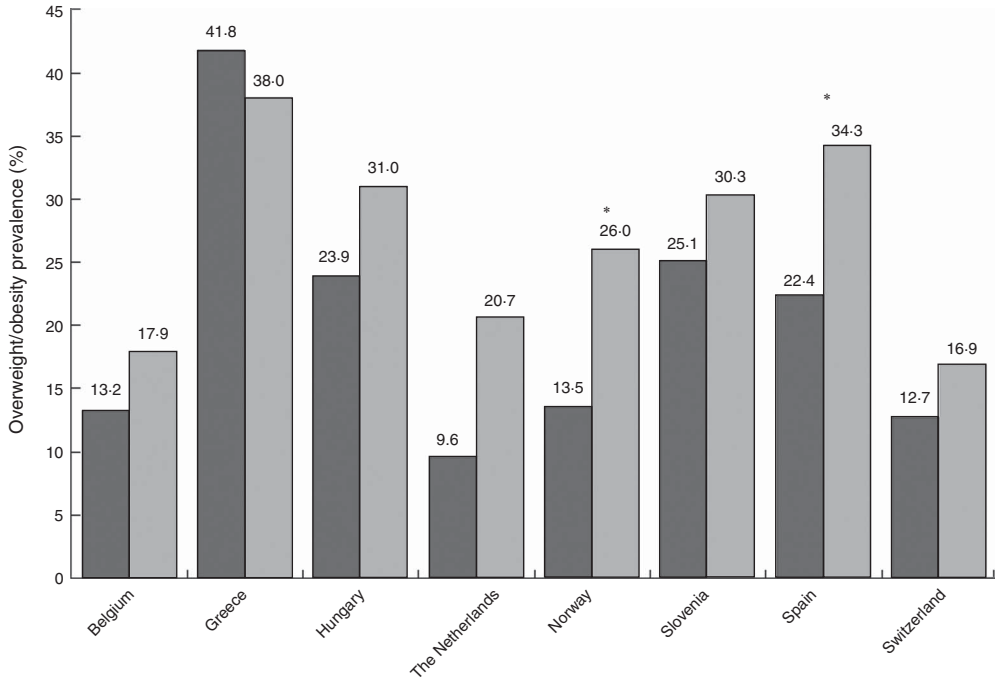

Fig. 3 Prevalence of overweight/obesity in 10- to 12-year-old children in Europe, according to their breakfast consumption habits on weekend days (■, daily breakfast consumption (DBC) on weekends; □, skips breakfast on weekends); the ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project, 2010. *$P < 0{\cdot}05$ for the comparison between DBC and breakfast skipping categories

parental occupational and educational statuses were significantly associated with children's overweight/obesity. Regarding path *a*, children's DBC was found to be significantly associated with parental nationality, occupational and educational statuses. Furthermore, as concerns path *b*, children's DBC was found to be significantly associated with children's overweight/obesity after controlling for gender, parental nationality and educational status, respectively.

Children's DBC significantly mediated the associations between parental nationality and parental educational status with children's overweight/obesity (path $a \times b$). However, as the total association (path c/c') between parental nationality and children's overweight/obesity was not statistically significant, the proportion mediated by children's DBC is reported only for the association between parental educational status and children's overweight/obesity for which path c/c' was statistically significant; this was found to be 17 % (Table 4).

Discussion

The objective of the current study was to investigate the associations of family sociodemographic characteristics with children's weight status and whether these potential associations are mediated by children's breakfast habits, using mediation analyses to jointly examine all objectives with a single type of analysis. To our knowledge, the present study is the first one examining the possible mediating role of one very important energy balance-related behaviour, i.e. breakfast consumption[39], in the association between family sociodemographic characteristics and children's overweight/obesity. Further to that, the current study represents a research attempt to look deeper into the associations and interactions between social, behavioural and clinical variables pointed to by the theoretical framework upon which the conceptualization and design of the ENERGY project were based[29]. According to the results derived from the mediation analyses, children's DBC was significantly related to all family sociodemographic characteristics examined (path *a*), with the exception of family structure. In particular, the current study showed that employment of both parents and higher educational status of at least one parent were positively associated with children's DBC on weekdays and/or weekends. This finding confirms the associations between family SES indices and breakfast habits reported in earlier US and European studies[17,23–25,40]. Furthermore, consistent with the findings of the Health Behaviour in School-aged Children (HBSC) study[23], the present study indicates that the association of family SES with children's DBC shows regional differences that could reflect differences in socio-cultural norms regarding breakfast consumption.

The findings of the present study additionally show that children's DBC varies widely within different European countries and between weekdays and weekends. More specifically, in only three out of eight countries do more than 80 % of children report eating breakfast daily on weekdays. However, children tend to consume breakfast more regularly on weekends, since in almost all countries

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Table 4 Association between selected demographic characteristics and children's overweight/obesity and the potential mediating effect of children's daily breakfast consumption (DBC) on weekdays and weekends on these associations in 10- to 12-year-old children in Europe; the ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project, 2010

Independent variable	*c*	SE	*c'*	SE	*a*	SE	*b*	SE	Comp(*c*)	SE	Comp(*c'*)	SE	Comp(*a*)	SE	Comp(*b*)	SE	Comp (*a*) × Comp(*b*)	SE	95 % CI of Comp (*a*) × Comp(*b*)	Mediated effect
Gender	**−0·297**	**0·097**	**−0·331**	**0·11**	0·012	0·052	**−0·578**	**0·171**	**−0·082**	**0·027**	**−0·089**	**0·029**	0·003	0·014	**−0·150**	**0·044**	−0·0004	0·002	−0·005; 0·004	N/A
Parental nationality	−0·077	0·091	−0·041	0·093	**0·451**	**0·124**	**−0·465**	**0·138**	−0·016	0·019	−0·008	0·019	**0·094**	**0·025**	**−0·122**	**0·036**	**−0·011**	**0·005**	**−0·020; −0·002**	–
Occupational status	**−0·188**	**0·084**	**−0·186**	**0·083**	**0·384**	**0·133**	−0·563	0·479	**−0·040**	**0·018**	−0·039	0·039	**0·083**	**0·028**	−0·147	0·124	−0·012	0·011	−0·034; 0·009	N/A
Parental educational status	**−0·404**	**0·111**	**−0·388**	**0·135**	**0·426**	**0·119**	**−0·711**	**0·171**	**−0·106**	**0·029**	**−0·099**	**0·035**	**0·111**	**0·031**	**−0·183**	**0·044**	**−0·020**	**0·007**	**−0·035; −0·005**	**17·0**

N/A, not applicable. Figures in bold indicate statistically significant findings.
Coefficient *c* is the estimate of the association between demographic characteristic (X) and overweight/obesity (Y), overall or total association, adjusted for country and school.
Coefficient *c'* is the estimate of the association between demographic characteristic (X) and overweight/obesity (Y), adjusted for the mediator (M); direct association.
Coefficient *a* is the estimate of the association between demographic characteristic (X) and children's DBC (M).
Coefficient *b* is the estimate of the association of children's breakfast consumption (M) and children's overweight/obesity (Y) after controlling for independent variable.
$\text{Comp}(a) = a \times \text{SD}(X)/\text{SD}(M')$.
$\text{Comp}(b) = b \times \text{SD}(M)/\text{SD}(Y'')$.
$\text{Comp}(c) = c \times \text{SD}(X)/\text{SD}(Y')$.
$\text{Comp}(c') = c' \times \text{SD}(X)/\text{SD}(Y'')$.
$\text{Var}(Y') = c^2 \times \text{Var}(X) + \pi^2/3$.
$\text{Var}(M') = a^2 \times \text{Var}(X) + \pi^2/3$.
$\text{Var}(Y'') = c'^2 \times \text{Var}(X) + b^2 \times \text{Var}(M) + 2 \times b \times c' \times \text{Cov}(X,M) + \pi^2/3$.
Comp(*a*) × Comp(*b*) is the product-of-coefficient estimate; mediated effect.
95 % CI of Comp(*a*) × Comp(*b*) is 95 % confidence interval of the mediated effect.
$\pi^2/3$ is the variance of the standard logistic distribution.

more than 80 % of children report higher DBC on both weekend days. The results of the present study for weekdays are consistent with the results from the HBSC study indicating that daily consumption of breakfast varied from 33 % to 75 % in several European countries[23], as well as with those reported in a previous study using 24 h recall data from the ENERGY project[40]. Variations in breakfast consumption across countries may be explained by differences in cultural and socio-economic factors as well as in the availability of foods and breakfast served at school.

Regarding associations of family sociodemographic characteristics with children's weight status, the current study reports lower likelihood of overweight and obesity in children whose parents were employed and had a higher level of education, as was also indicated by earlier papers that present results from the ENERGY project[8,40]. This finding is also in line with a recent review of previous cross-sectional studies[9] and could be partially ascribed to the less favourable dietary patterns (e.g. the higher consumption of energy-dense foods), the lower engagement in physical activity and the more time spent on sedentary activities by children of less educated parents[41–43]. Additionally, children of higher-SES families tend to be more adherent and responsive to health-related recommendations and media messages compared with children of lower-SES families[44].

Our finding concerning the negative association observed between children's DBC and overweight/obesity is in line with those reported by earlier papers from the ENERGY project[26,40], as well as from longitudinal studies[17,45]. An interpretation of these associations could be that DBC increases satiety and prevents consumption of high-energy-dense snacks later in the morning, thus favouring energy balance, which in turn helps maintenance of normal body weight[46]. Another possible explanation of our results could be that breakfast consumption can also be a proxy of a more general healthy lifestyle[47].

However, none of the previous studies reporting significant associations between family sociodemographic characteristics and children's overweight/obesity have explored the potential mediating effect of breakfast consumption habits. The findings of the present study show that children's DBC mediated the associations of parental nationality and educational level with children's overweight and obesity. However, DBC was not a significant mediator of the associations between gender and children's overweight/obesity, most likely due to the non-significant association between gender and DBC (path *a*). Furthermore, no significant mediating effect of DBC was observed in the association between parental occupational status and children's overweight/obesity, and this is probably due to the borderline ($P = 0{\cdot}053$), but yet non-significant association between DBC and children's overweight/obesity (path *b*). Further to the above, according to MacKinnon it is possible to have statistically significant *a* and/or *b* paths in the absence of a significant *c* path[36].

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This is confirmed by the findings of the present study, since in the case of the mediating effect of DBC in the association between parental nationality and children's overweight/obesity path *c* was not statistically significant. This specific result showing a mediating effect of children's DBC but no association between parental nationality and children's weight status (the primary association of interest) is probably indicative of other possible factors (suppressors) influencing children's body weight and/or of higher statistical power to detect a mediating than a total effect. In the case of the mediating effect of DBC in the association between parental educational level and children's overweight/obesity, both *c* and *c′* paths, as well as *a* and *b* paths, were statistically significant, which might indicate that other factors also play a role in explaining the association between parental education and children's overweight status.

The major strengths of the present study are the large sample size obtained from different European countries, the use of a standardized protocol for data collection and data processing, and the objectively measured weight and height in children. However, there are also certain limitations. First and foremost, a causal relationship cannot be identified due to the cross-sectional design of the study. For instance, it may be that overweight children start skipping breakfast as a strategy to lose weight. Second, we used a rather crude dichotomous variable for DBC, i.e. distinguishing between respondents who reported to eat breakfast every day and those who reported to skip breakfast at least once weekly. This means that no distinction between (for example) children who skipped breakfast at least one day at weekdays and one day at weekends and those who never eat breakfast was made. The fact that, despite this crude measure, strong associations and mediation are found may suggest that these associations and mediation are likely to be even stronger if more detailed distinctions in breakfast habits could have been analysed. Third, the use of mediation analyses to test for possible mediating effect on associations between cross-sectional data, instead of longitudinal data, represents another limitation of the current study. Lastly, dietary behaviours are based on self-reports and may therefore be subjected to misreporting bias.

Conclusion

In conclusion, the present study showed that DBC partly mediated the association of parental education and ethnicity with overweight/obesity in their children. From a public health perspective, our findings suggest that promotion of DBC in families with non-native and less educated parents could be considered a promising component of childhood obesity preventive initiatives. Nevertheless, further studies – preferably intervention studies – are needed to provide additional evidence on these associations and on the mediating effect of children's breakfast consumption habits.

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