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Parental weight status and early adolescence body weight in association with socioeconomic factors

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Abstract:

BACKGROUND: Childhood obesity remains a major health issue. The understanding of the multifactorial nature of childhood obesity remains the cornerstone to eliminate the rising trends. This study aimed to examine the association between parental and childhood weight status, in relation to various socioeconomic (SE) factors.

METHODS: A cross-sectional survey was conducted including 1190 children aged 10–12 years and their parents, during school years 2014–2016. Primary schools from five Greek counties (including Athens metropolitan area) were randomly selected. Parental and child data were collected through self-administered, anonymous questionnaires. Children's weight status was based on gender- and age-specific tables derived from the International Obesity Task Force body mass index (BMI) cut offs. General Linear Model (GLM), Univariate and multivariate analyses were applied. Multiple logistic regressions was used to determine the association between children and parents' weight status.

RESULTS: Childhood prevalence of overweight and obesity was 25.9% (21.8% overweight and 4.1% obese), with prevalence being significantly higher in males (31.7% compared to 21.3%; *P* for gender differences < 0.001). The percent of overweight and obese male (34.4% and 43.1%) and female children (20.3% and 31.8%) significantly increased with paternal overweight and obesity status, respectively. The same relationship was observed between male children and maternal overweight and obesity status (43.4% and 65.7%). This was not evident among females (27% and 23.2%). Regression analysis showed a significant positive association with parental BMI, a negative association with both parental educational levels (low to high), living space, and parental age ($P < 0.05$, for all). Children's likelihood of being overweight or obese increased significantly with increasing parental weight status ($P < 0.001$).

CONCLUSIONS: Parental weight status remained the most significant predictive factor for early adolescence obesity among various SE factors. Health promotion strategies should consider parental education as an effective childhood obesity preventive measure.

Keywords:

Children weight status, health promotion, obesity risk factors, parental weight status, socioeconomic factors

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Significance of this Study

The findings of this study underline the significant correlation between parental and children weight status. Moreover, it was observed that parental weight status was the main explanatory variable of childhood overweight and obesity, after controlling for potential socioeconomic factors. Additionally, the gender of young adolescents was found to be a significant factor in weight status,

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with males having a 3-fold higher risk when both parents were overweight, compared to 2-fold risk for female children.

Introduction

According to the most recent World Health Organization (WHO) report, obesity has tripled worldwide and is characterized a disease state with epidemic attributes.[1] One in five adults is obese, and nearly, one in six children is overweight or obese, across the Organization for Economic Co-operation and Development countries, with Greece being in the 11th position.[2,3] Obesity is a multifactorial disease and is one of the major risk factors of the most predominant chronic diseases, including type 2 diabetes mellitus, cardiovascular diseases (CVD), hypertension, some forms of cancer, osteoarthritis, and respiratory problems.[4-6] The economic burden of obesity is therefore large. It has been estimated that almost 25% of the direct health care costs are attributed to overweight, excluding indirect costs such as loss of labor productivity due to morbidity, mortality, or informal care.[7] Furthermore, the earlier the onset of overweight and obesity, the greater the burden since it is well documented that excess weight gain during childhood is independently associated with adulthood obesity, increased CVD risk as well as with CVD comorbidities.[8,9]

Various socioenvironmental and behavioral factors have been related to the increase in overweight and obesity rates. The continuous and rapid rising trends of excess body weight witness social influence as the cornerstone of unhealthy bodyweight rather than heredity.[10-12] Specifically, child age and various socioeconomic (SE) factors including parental education and household income have been identified to have a strong influence on parental–child body mass index (BMI) association.[13] However, data on the role of SE status (SES) on childhood obesity are inconsistent since parental overweight and obesity may also significantly affect childhood body weight status.[14] In a recent 12-country study including Africa, USA, South Asia, and three European countries (Finland, Portugal, UK), a positive association between parental and child overweight with mother's BMI being more consistent with child's BMI was observed.[15] These risk factors and their association with child overweight and obesity need to be better understood to develop appropriate child overweight programs. Thus, the aim of the present study was to examine the association between parental and childhood weight status, in relation to various SES, accounting for known perinatal factors, such as breastfeeding and gestational diabetes.

Methods

Participants and sampling procedures

The study was conducted in the greater metropolitan Athens area, in Heraklion, the capital City of the Island of Crete and in three main counties of the Peloponnese peninsula (Sparta, Kalamata, Pyrgos), during the school years 2014–2015 and 2015–2016. The specific regions were selected since they represent large urban and rural municipalities and therefore a more representative sample was obtained. Schools were selected using random sampling from a list of schools provided by the Greek Ministry of Education. In total, 47 schools were selected (32 from Athens, 5 from Heraklion, Crete, 3 from Pyrgos, 2 from Kalamata, and 5 from Sparta, Peloponnese). Parental written consent was obtained before enrolling children in the study. Participation rate ranged from 95% to 100% between schools, without any significant differences between the studied areas. A total of 1728 students (785 males), aged 10–12 years of age, attending the 5th and 6th grade of primary school, were enrolled in the study. All children's parents were also invited to participate, with 68.9% response rate being achieved (n = 1190). Thus, complete detailed information was available from 1190 children–parents' pairs; 511 male children, 660 female children (19 missing information for gender), as well as 1060 fathers and 1089 mothers. The working sample was adequate to evaluate effect size measures' differences of 20% at <5% level of significance, achieving 85% statistical power.

Children and parent questionnaires

Each child was asked by the study's researcher or the school teacher to complete an anonymous questionnaire. To increase the accuracy of responses obtained, study's investigators, in collaboration with children's teachers, assisted using practical examples. Children's questionnaire consisted of a total 53 questions assessing daily activities such as dietary habits, physical activity, knowledge, and perceptions on risk factors for chronic diseases, as well as questions about self-perceptions and stress management. A team of experts in the field of CVD epidemiology, public health, children's psychology, and school performance were involved in the development of the questionnaires.

For the purpose of the present study, information on (a) demographic characteristics (age, gender, place of residence, nationality, number of siblings, and birth order) and (b) anthropometric measurements (height, weight, for BMI calculation) using scale and tape measure, over skin-tight clothes were evaluated.

Parental questionnaires were given to the children, to be completed by any of their parents at home. Analytic

instructions were given for completion, and they were asked to return the completed questionnaires to the school setting. In most cases, questionnaires were completed by one parent, usually by the mother (75%). Parental questionnaires consisted of 36 questions on (a) family demographic characteristics (place of residence, nationality) and anthropometric self-reported data (height, weight, for BMI calculation), (b) family type was categorized into two groups (both parents or single parent), (c) child's perinatal history (type of delivery, history of breastfeeding, gestational diabetes mellitus [GDM]) and (d) various family SES – maternal and paternal educational level and occupational status.

Socioeconomic status assessment

SES indicators included maternal–paternal profession, maternal–paternal education level, and homeownership and living space. Educational level was categorized into (i) lower secondary or less and included all individuals having completes <9 years of schooling, (ii) higher secondary education including individuals having completed 12 years of mandatory education, (iii) postsecondary education for all those that had a Bachelor degree, and (iv) higher third level education for all individuals with a Masters alone or Masters and PhD. Parental profession included categories found in Greece (including homemaker for women). More specifically, categories included public servant, private sector employee, freelancer, pensioner, unemployed, and homemaker (for women). No significant differences were found between these categories for either parent, and therefore, these were grouped into employed/unemployed for further analysis (homemaker = unemployed).

Individuals were asked also whether they owned their home (yes/no) and its size (expressed as living space from now on), as a proxy to income status. The latter was categorized based on the square meters in <60 m^2, 61–90 m^2, 91–120 m^2, and >120 m^2.

Parental and child weight categorization

For children, weight status was categorized using the age- and gender-specific International Obesity Task Force (IOTF) BMI cutoff criteria,[16] where child's BMI is related to the relevant adult's BMI, according to age in months and gender. Children were, therefore, also categorized as underweight, normal overweight, and obese. Under- and normal-weight categories were combined in both cases (for parents and children) since the percent of the population that was underweight was limited. All associations were performed using underweight/normal BMI as the reference category. Weight status, however, was calculated by taking the mean value (for males and females), from the IOTF tables, for each weight category. Parental weight status was defined based on the WHO (BMI, in kg/m^2) cutoffs: underweight: <18.5 kg/m^2, normal weight: 18.5–24.9 kg/m^2, overweight: 25–29.9 kg/m^2, and obese: >30 kg/m^2. BMI was calculated as weight (in kilograms) divided by height (in meters) squared.

Bioethics

The study was approved by the Institute of Educational Policy of the Ministry of Education and Religious Affairs and was carried out in accordance with the Declaration of Helsinki (1989). The research protocol was also approved of by the Harokopio University Bioethics Committee (code of approval F15/396/72005/C1). The school principals, teachers, parents, and students were informed about the aims and procedures of the study. A signed parental consent was obtained before the completion of the questionnaires.

Statistical analysis

Group mean differences were tested using student *t*-test, for normally distributed variables. Pearson's Chi-squared test was used to examine differences between categorical variables. Pairwise correlations, with Bonferroni correction, between parent and child BMI as well as children's and parental weight status were performed for each parent separately, using correlation coefficients. Although specific BMI cutoff points are widely accepted and used, children's BMI was primarily examined in relation to parental BMI (both) as a continuous variable using general linear models (GLM; accounts for random missing data per variable included). This was done to decrease study power loss due to the assumption of "homogeneity of risk " within categories.[17] Univariate and multivariate analyses were applied. Multiple logistic regression was used to determine the likelihood of children being overweight or obese (compared to healthy weight children), according to parental weight status for one parent or both parents (mother overweight/obese; father overweight/obese; both parents overweight/obese). Variables found to be statistically associated with children's BMI in GLM were used in the multiple logistic models. Breastfeeding was used as a perinatal adjustment factor (although not significant in the GLM assessment) due to a-priory evidence of potential association with children's weight status. Extended Mantel–Haenszel (M-H) Statistics (otherwise known as Cochran M-H) was performed to examine linear trend between parental and child weight status, reinforcing the potential association between the two variables (p for trend). Collinearity between the independent variables was tested using the variance inflation factor. Two-sided hypothesis tests were considered with the level of significance set at alpha = 5%. All analyses were conducted using STATA 14.0 (StataCorp LP, College Station, Texas, Ltd).

Results

A total of 26.4% of male children were categorized overweight and 5.3% obese compared to 18.2% of female children and 3.1%, respectively (P for gender differences <0.001). In addition, 51.2% of fathers and 25.9% of mothers were categorized as overweight, and18.3% of fathers and 7.2% of mothers were categorized as obese.

Among normal-weight fathers, 19.7% of male and 15.1% of female children were overweight or obese. This increased to 34% and 20.3% for overweight fathers [Figure 1].

In Table 1, several children's and parents' characteristics, including anthropometric, SES, and perinatal factors, are depicted. A strong association was observed between parental and child body weight status (all Chi-squared $P < 0.05$) as it is also illustrated in Figure 1. The percent of overweight and obese male children significantly increased with maternal overweight and obese status. The same relationship was observed between female children and paternal overweight, but not obese status. Moreover, pairwise Pearson correlations showed significant linear associations between maternal-child BMI ($r^2 = 0.21$, $P < 0.001$), paternal-child BMI ($r^2 = 0.19$, $P < 0.001$), and maternal-paternal BMI ($r^2 = 0.26$, $P < 0.001$). A higher effect size of the association was observed between male children and parental BMI ($r^2 = 0.27$ with maternal, $r^2 = 0.23$ with paternal, $P < 0.001$) as compared to female children ($r^2 = 0.15$ with maternal, $r^2 = 0.17$ with paternal, $P < 0.001$).

Table 2 shows univariate and stepwise GLM adjustment of SE, perinatal, and parental factors in relation to children's BMI level. Regression analysis showed a significant positive association between paternal profession and with maternal and paternal BMI and a negative association with both parental educational levels (low to high) and living space ($P < 0.05$, for all). Specifically, children whose father was unemployed had a significantly higher BMI. Furthermore, the higher the paternal BMI, the higher the children's BMI with a stronger association found among maternal-child BMI (0.16; 95% confidence interval [CI]: 0.118–0.212). On the contrary, the larger the living space and the higher the parental education (both maternal and paternal), the lower the children's BMI. In the fully adjusted model, paternal age was negatively associated with children's BMI whereas all SE factors that were significant in the univariate analysis became insignificant, suggesting a potential confounding role.

Parental and child weight status

Further, multiple logistic regression analyses evaluated the likelihood of a child being overweight or obese, by parental weight status [Table 3]. Results are shown in

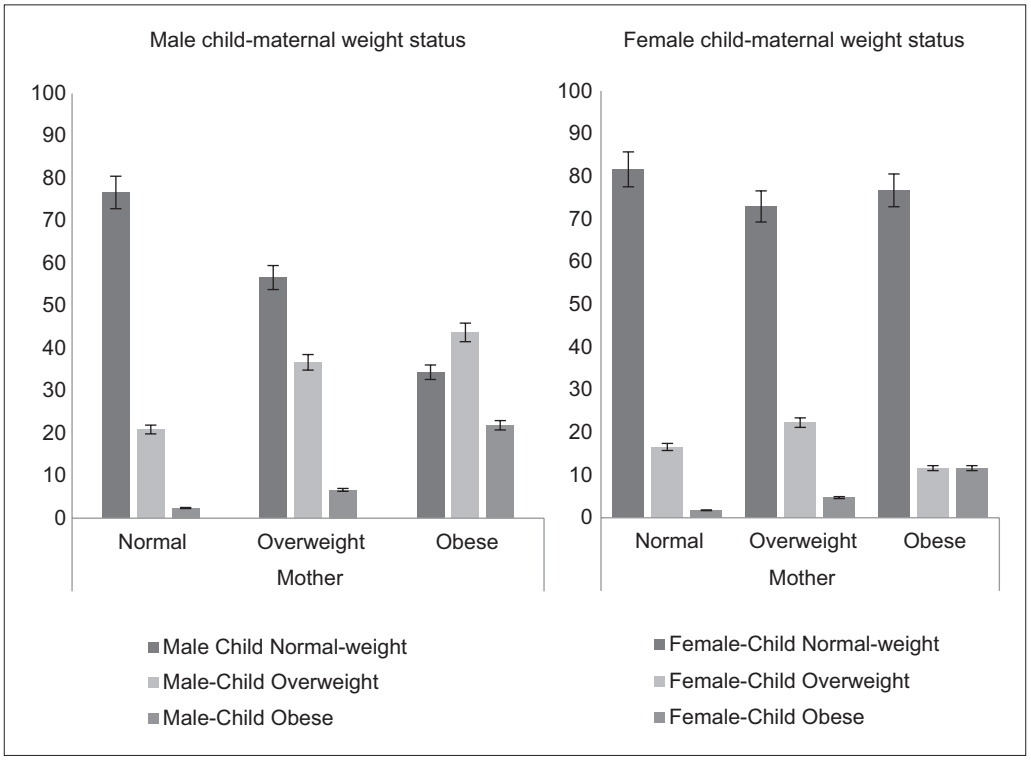

Figure 1: A classification analysis according to child–parent overweight/obesity status

Table 1: Child and parental characteristics of the sample

Child/Parental characteristics	Total sample (*n*=1190), *n* (%)	Male children (*n*=511), *n* (%)	Female children (*n*=660), *n* (%)	*P**
Age (yrs)	11.2 (0.7)	11.2 (0.8)	11.2 (0.8)	0.738
Weight (kg)	43.5 (9.4)	44.3 (9.5)	43.1 (9.3)	0.035
Height (cm)	151.1 (8.9)	150.7 (9.0)	151.4 (8.8)	0.214
BMI (kg/m^2)	19.2 (3.4)	19.5 (3.5)	19.0 (3.4)	0.002
Weight status**				
Under- and normal-weight	835 (74.2)	334 (68.3)	501 (78.7)	<0.001
Overweight	245 (21.8)	129 (26.4)	116 (18.2)	
Obese	46 (4.1)	26 (5.3)	20 (3.1)	
Has siblings (yes %)	928 (83.8)	402 (83.8)	526 (83.9)	0.949
Family type				
Both parents	1018 (89.0)	445 (89.0)	573 (89.0)	0.989
Single parent	126 (11.0)	55 (11.0)	71 (11.0)	
Parental characteristics				
Maternal age (years)	41.6 (4.4)	41.9 (4.3)	41.3 (4.6)	0.037
BMI mother's (kg/m^2)	24.0 (4.0)	24.1 (4.0)	24.0 (4.0)	0.867
Maternal weight status**				
Under- and normal-weight	717 (66.9)	302 (65.2)	415 (68.1)	0.586
Overweight	278 (25.9)	127 (27.4)	151 (24.8)	
Obese	77 (7.2)	34 (7.3)	43 (7.1)	
Paternal age (years)	45.9 (5.4)	46.3 (5.4)	45.6 (5.4)	0.02
Paternal BMI (kg/m^2)	27.0 (3.7)	26.9 (3.6)	27.1 (3.8)	0.448
Paternal weight status**				
Under - and normal-weight	319 (30.5)	143 (31.5)	176 (29.8)	0.836
Overweight	535 (51.2)	229 (50.4)	306 (51.8)	
Obese	191 (18.3)	82 (18.1)	109 (18.4)	
Socioeconomic indicators				
Maternal profession				
Public servant	239 (20.9)	110 (21.9)	129 (20.1)	0.390
Private sector employee	357 (31.2)	156 (31.0)	201 (31.4)	
Freelancer	152 (13.3)	70 (13.9)	82 (12.8)	
Pensioner	40 (3.5)	22 (4.4)	18 (2.8)	
Unemployed	186 (16.3)	71 (14.1)	115 (17.9)	
Homemaker	170 (14.9)	74 (14.7)	96 (15.0)	
Maternal educational level				
Lower secondary or less	121 (10.6)	48 (9.7)	73 (11.4)	0.687
Higher secondary education	505 (44.4)	220 (44.3)	285 (44.5)	
Postsecondary education	420 (36.9)	191 (38.4)	229 (35.8)	
Higher third-level education	91 (8.0)	38 (7.7)	53 (8.3)	
Paternal profession				
Public servant	237 (21.1)	102 (20.6)	135 (21.4)	0.216
Private sector employee	429 (38.1)	181 (36.6)	248 (39.3)	
Freelancer	321 (28.5)	156 (31.5)	165 (26.2)	
Pensioner	46 (4.1)	22 (4.4)	24 (3.8)	
Unemployed	93 (8.3)	34 (6.9)	59 (9.4)	
Paternal educational level				
Lower secondary or less	187 (16.5)	74 (14.9)	113 (17.6)	0.582
Higher secondary education	498 (43.8)	216 (43.6)	282 (43.9)	
Postsecondary education	339 (29.8)	152 (30.7)	187 (29.1)	
Higher third-level education	113 (9.9)	53 (10.7)	60 (9.4)	
Homeownership (%)	846 (76.4)	373 (76.9)	473 (76.1)	0.649

Contd...

Table 1: Contd...

	Total sample (*n*=1190), *n* (%)	Male children (*n*=511), *n* (%)	Female children (*n*=660), *n* (%)	*P**
Living space (m^2)				
<60	72 (6.3)	34 (6.8)	38 (5.9)	0.318
61–90	409 (35.7)	173 (34.6)	236 (36.5)	
91–120	459 (40.0)	192 (38.4)	267 (41.3)	
>121	207 (18.1)	101 (20.2)	106 (16.4)	
Perinatal characteristics				
Breastfeeding[a] (yes %)	927 (81.5)	403 (81.6)	524 (81.5)	0.970
Breastfeeding duration (months)				
<1 month	152 (16.4)	73 (17.9)	79 (15.1)	0.613
1–3 months	283 (30.5)	117 (28.8)	166 (31.8)	
3–6 months	238 (25.6)	104 (25.5)	134 (25.7)	
>6 months	256 (27.6)	113 (27.8)	143 (27.4)	
Gestational diabetes mellitus (yes %)	81 (8.0)	45 (10.0)	36 (6.4)	0.032

Normally distributed variables presented as mean (SD) and categorical variables as frequencies (%), *Level of significance set at *P*<0.05; tested via student *t*-test or Mann–Whitney, for continuous normally distributed or skewed variables, respectively, and Chi-square test for categorical variables, [a]Total months of breastfeeding, **Weight status is defined based on BMI cut-offs for adults and on IOTF cut-off criteria for children. SD=Standard deviation, IOTF=International obesity task force, BMI=Body mass index

Table 2: Results from general linear models that evaluated children's body mass index with various socioeconomic, lifestyle, and body mass index level of their parents

Parental Characteristics	Univariate analysis		Adjusted analysis	
	b-coefficient	95% CI	b-coefficient	95% CI
Maternal age (/1 yr)	−0.30	−0.074-0.015	0.01	−0.060-0.083
Paternal age (/1 yr)	−0.30	−0.066-0.001	−0.07*	−0.129-−0.013
Maternal BMI (kg/m^2)	0.16*	0.118-0.212	0.10*	0.041-0.158
Paternal BMI (kg/m^2)	0.15*	0.102-0.206	0.12*	0.058-0.188
Maternal educational level (low-to-high)	−0.47*	−0.703-−0.227	−0.21	−0.571-0.161
Paternal educational level (low-to-high)	−0.47*	−0.693-−0.259	−0.22	−0.342-0.299
Maternal profession (unemployed/employed)	0.04	−0.067-0.146	−0.03	−0.162-0.111
Paternal profession (unemployed/employed)	0.20*	0.032-0.377	0.14	−0.075-0.357
Living space (m^2)	−0.27*	−0.498-−0.049	−0.13	−0.434-0.176
Homeownership (yes/no)	0.03	−0.429-0.484	0.11	−0.444-0.668
Siblings (yes/no)	−0.12	−0.640-0.392	−0.41	−1.066-0.244
Breastfeeding (yes/no)	−0.42	−0.905-0.064	0.36	−0.254-0.977
Gestational diabetes mellitus (yes/no)	0.16	−0.568-0.886	−0.09	−0.937-0.767

**P*<0.05, models were adjusted for children's age and gender. BMI=Body mass index, CI=Confidence interval

total and stratified by gender since gender differences were found at baseline levels.

Maternal weight status

The odds of being overweight were 1.8 (95% CI: 1.265, 2.614) times higher in children whose mother was overweight and 1.9 (95% CI: 1.033, 3.563) times higher if their mother was obese. Obesity likelihood was three times higher and 10 times higher, respectively. The association remained significant for male children, with the likelihood of being overweight or obese increasing 5–13 times, in case of maternal obesity, respectively. In female children, no significant association was found between being overweight and maternal weight status; however, female children were more likely to be obese when their mother was overweight or obese (odd ratios [OR]: 4.2; 95% CI: 1.292, 13.471 and OR: 10.6; 95% CI: 2.80, 40.055, respectively).

Paternal weight status

Paternal overweight and obesity status were associated with children's likelihood of being overweight (OR: 1.9; 95% CI: 1.237, 2.752 and OR: 2.5; 95% CI: 1.559, 4.053, respectively). However, paternal obesity, and not overweight status, was associated only with childhood obesity risk. Results remained significant in (i) overweight male children with overweight and obese fathers, (ii) obese male children with obese fathers, and (iii) overweight female children with obese fathers.

Both parents' overweight

Children whose parents were both overweight were two times (95% CI: 1.302, 3.368) more likely of being overweight compared to under- and normal-weight children. When stratified by gender, only male children were 2.9 times (95% CI: 1.446, 5.786) more likely of being overweight. No other significant differences were found.

Table 3: Results from multiple logistic regression odds ratio (95% confidence interval) on children's likelihood of being overweight-obese compared to parent's weight status, using multivariable models*

Parental/Children body weight	Total sample		Male children		Female children		
	Overweight	Obese	Overweight	Obese	Overweight	Obese	*P* for trend[a]
Maternal weight							
Normal	-	-	-	-	-	-	<0.001
Overweight	1.82 (1.265, 2.614)	3.13 (1.425, 6.897)	2.29 (1.352, 3.866)	3.41 (1.108, 10.473)	1.48 (0.880, 2.476)	4.17 (1.292, 13.471)	
Obese	1.92 (1.033, 3.563)	10.38 (4.118, 26.173)	5.32 (2.158, 13.136)	13.61 (3.365, 55.004)	0.70 (0.236, 2.107)	10.59 (2.80, 40.055)	
Paternal weight							
Normal	-	-	-	-	-	-	<0.001
Overweight	1.85 (1.237, 2.752)	1.12 (0.472, 2.673)	2.19 (1.249, 3.329)	1.43 (0.346, 5.922)	1.65 (0.928, 2.969)	1.05 (0.339, 3.221)	
Obese	2.51 (1.559, 4.053)	3.12 (1.271, 7.646)	2.37 (1.167, 4.798)	6.93 (1.772, 27.085)	2.78 (1.429, 5.413)	1.39 (0.349, 5.555)	
Overweight parents							
None	-	-	-	-	-	-	0.024
One parent	1.19 (0.818, 1.718)	0.83 (0.389, 1.768)	1.44 (0.835, 2.467)	1.12 (0.392, 3.179)	1.05 (0.623, 1.762)	0.71 (0.218, 2.309)	
Two parents	2.09 (1.302, 3.368)	1.26 (0.464, 3.412)	2.89 (1.446, 5.786)	0.45 (0.052, 3.894)	1.61 (0.817, 3.156)	2.33 (0.677, 8.033)	
Obese parents			[b]	[b]	[b]	[b]	
None	-	-	-	-	-	-	<0.001
One parent	1.52 (1.013, 2.291)	3.29 (1.509, 7.175)	-	-	-	-	
Two parents	2.61 (1.172, 5.777)	10.44 (3.216, 33.877)	-	-	-	-	

*Compared to children's baseline (healthy weight), OR adjusted for child's age, gender (only in total), parental education, paternal profession, living space and breastfeeding, [a]*P* for trend based on extended M-H statistics, stratified by age, [b]N/A results were not considered since very small sample size (no power, large variation). OR = Odd ratios, N/A = Not available

Both parents' obese

Results for total sample for both parents being obese are only depicted. Results are not stratified by gender in this case, due to the small number of data, hence the low power analysis by gender. Results show that having one or both parents obese significantly increases the odds for children being overweight or obese (OR for both parents: 2.61, 95% CI: 1.172, 5.777, and 10.44 95% CI: 3.216, 33.877, respectively).

Further analysis showed evidence of significant trend among children being more likely to become overweight or obese if one or both of their parents were overweight or obese, respectively. An additive effect may be present.

Discussion

The study aimed to examine the association between parental weight status, familial SES, and child overweight and obesity. The results underlined three principal findings. First, the prevalence of child overweight and obesity was high and significantly correlated with parental weight status. Second, parental weight status was the main explanatory variable of childhood overweight and obesity in this study. Children from families with overweight and/or obese parents were at significantly higher risk to be overweight or obese at age 10–12 years. The risk significantly increased if both parents were overweight or obese, up to 10 times. The third main finding was the paternal role in children's risk for overweight and obesity. Other than parental educational level, living space, paternal profession, and age, with the latter being underlined, were associated with the main outcome.

In more detail, about 39% of the children that had both of their parents overweight or obese were overweight (31%) and obese (7.8%), as well, compared to a prevalence of approximately 15% when both parents were normal weight (for two-parent families). Having normal weight parents seems to decrease children's risk of overweight and obesity. This has been confirmed by other studies.[18] Another important finding was the association of males–parental weight status correlation. Overweight and obesity prevalence was higher among male children, and this was more strongly correlated with both maternal and paternal BMI, compared to female children. This may explain gender differences found in risk for overweight and obesity, with males being found to have a 3-fold higher risk in case of both parents being overweight, compared to 2-fold risk for female children. The fact that both parents were overweight compared to neither

or one parent only doubled the risk of female children obesity and tripled the risk of male children, apart from heredity, may also suggest unhealthy lifestyle practices within the family environment that play a significant role model for the children.[19]

Weight status is a complex situation combining genetic, behavioral, and environmental factors, indicating family susceptibility of becoming obese. In line with the present results, mother's overweight has been found more consistently associated with child overweight compared to father's overweight.[15] A possible explanation was attributed to the fact that overweight mothers misperceive their children's excess weight problems compared to normal weight mothers,[20] with more recent data implying that over time mothers tend to underestimate their children's body weight and they classify them as overweight only when they are in the obese range.[21] This can possibly be explained by body image gender differences, since female children, even in preadolescence age, are more aware of their body image.[22] Furthermore, parents may be more likely to identify their daughter's weight status than their son's, implying cultural differences and limited health literacy.[23,24]

Parental age and children body weight status have also been studied in some previous studies. Even though the mechanisms behind this association are not clear, and may be prone to bias, a higher BMI in children born by older mothers has been reported.[25-27] In the present analysis, only paternal age was inversely associated with children's BMI level. In line with the present results, a reduction in children's BMI and truncal fat was observed with increased paternal age at childbirth[28] whereas a positive relationship between paternal age and offspring's BMI was documented.[29] As there is an increasing trend in late parental reproductive age, efforts should be directed toward the long-term effects on children's health outcomes.

Various SE factors were found related to children's weight status in preliminary crude analysis including parental education, household size, and paternal profession. The higher parental education level and larger home size were negatively associated with children's BMI whereas father's unemployment was positively associated. However, it should be underlined that in the adjusted analysis the SES factors lost its significance, in agreement with other recent study, suggesting a potential confounding effect.[18] Within the multidimensional nature of overweight/obesity, both socioenvironmental and biological factors contribute to the abnormal weight gain. Indeed, the results on SES and children's BMI are conflicting with the impact of parental education level being attenuated by the country's financial status.[30,31] In some "wealthy" countries, a negative relationship has been documented between parental education and child overweight[30] whereas a positive association has been revealed in low economic countries.[31] Employment status is also a strong SES indicator. However, its association with childhood obesity has rarely been studied. A very recent study showed that having a father unemployed at one point, during childhood, was significantly associated with higher BMI in adult life.[32] The relationship between parental employment status and children's BMI level was attenuated when parental weight status and perinatal factors were accounted for.

Living space was also analyzed here and used as a proxy measure of income level, to account for income misreporting. Living in larger homes was negatively associated with BMI in univariate analysis, in accordance with studies showing a reverse relationship between high income and children's weight status[33] but lost its significance when other characteristics were accounted for. The potential mediating role of other sociodemographic factors such as parental employment status or education level may have affected the significance of this SE indicator on defining children's BMI status.

In preliminary data examination, perinatal factors that have been previously reported to potentially be associated with childhood weight status were accounted for. Gender differences were found for the presence of GDM. GDM has been proposed to act as an intermediate factor in the maternal–child obesity relationship.[34] In addition, a meta-analysis of cohort studies found that breastfeeding decreases risk of overweight in children.[35] These factors were therefore accounted for in the analysis to adjust for potential confounding.

Furthermore, although genetic predisposition may interpret some of the above findings, parent weight status appears to be the most significant independent predictor of childhood obesity, in concordance with other studies.[18] Underlined SE factors should be accounted for however other "parental-taught" lifestyle factors, and behaviors should also be studied.[36]

This was an observational study and has, therefore, some limitations that should be considered. No temporal relationship and hence causal inferences can be made. Furthermore, the sample was originated from specific parts of Greece, which limits the generalizability of the findings to the entire Greek children's population aged 10–12 years. However, due to the stratified random sampling scheme that was implemented and the large size of the final sample, its representativeness could be considered high for urban settings. This study adds the role of the SEstatus to the relation betwen

parental and childhood obesity, an area that has not been extensively studied and with many researchers still underlying the potential dilution in the association between parental and child weight status when these factors are accouted for. This study therefore provides an up-to-date insight in the aforementioned association, showing that regardless, SE factors, parental body weight is the most significant predictor of children's' body weight. A potential limitation may also be reporting bias due to the self-reporting questionnaires. The presence of a trained investigator throughout the completion of the questionnaire for addressing any potential misconceptions about it increases the validity of the given responses. Parental weight and height were self-reported; thus, they may be subjected to bias due to overestimate height and underestimate weight.[37] Despite the limitations of the present work, due to its observational design, the reported findings deserve further attention for the development of effective strategies to fight childhood obesity.

Conclusion

Parental–child overweight and obesity association remained the main predictor, after assessing various SE factors. Childhood overweight and obesity remain an alarming public health problem worldwide, and parents may have a pivotal role in this problem. It is therefore recommended that health promotion strategies and intervention programs should be family directed, to increase awareness on behavioral and lifestyle risk factors.

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Conflicts of interest

There are no conflicts of interest.

References

1. WHO Fact Sheet Obesity and Overweight; 2018. Available from: http://www.who.int/mediacentre/factsheets/fs311/en/. [Last accessed on 2018 Nov 10].
2. Organization for Economic Co-operation and Development. The Country Health Profile Series. Organization for Economic Co-operation and Development; 2017. Available from: https://www.ec.europa.eu/health/sites/health/files/state/docs/chp_gr_english.pdf. [Last accessed on 2018 Nov 10].
3. Eurostat; 2016. Available from: http://www.greece.greekreporter.com/2016/10/21/eurostat-Greece-has-the-11th-most-obese-European-citizens/. [Last accessed on 2018 Nov 10].
4. Webber L, Divajeva D, Marsh T, McPherson K, Brown M, Galea G, *et al*. The future burden of obesity-related diseases in the 53 WHO European-region countries and the impact of effective interventions: A modelling study. BMJ Open 2014;4:e004787.
5. Azevedo PS, Minicucci MF, Zornoff LA. Obesity: A growing multifaceted problem. Arq Bras Cardiol 2015;105:448-9.
6. Campbell MK. Biological, environmental, and social influences on childhood obesity. Pediatr Res 2016;79:205-11.
7. Lette M, Bemelmans WJ, Breda J, Slobbe LC, Dias J, Boshuizen HC, *et al*. Health care costs attributable to overweight calculated in a standardized way for three European countries. Eur J Health Econ 2016;17:61-9.
8. Schellong K, Schulz S, Harder T, Plagemann A. Birth weight and long-term overweight risk: Systematic review and a meta-analysis including 643,902 persons from 66 studies and 26 countries globally. PLoS One 2012;7:e47776.
9. Juhola J, Magnussen CG, Viikari JS, Kähönen M, Hutri-Kähönen N, Jula A, *et al*. Tracking of serum lipid levels, blood pressure, and body mass index from childhood to adulthood: The cardiovascular risk in Young Finns study. J Pediatr 2011;159:584-90.
10. Schwartz MB, Puhl R. Childhood obesity: A societal problem to solve. Obes Rev 2003;4:57-71.
11. Patrick H, Nicklas TA. A review of family and social determinants of children's eating patterns and diet quality. J Am Coll Nutr 2005;24:83-92.
12. Lawlor DA, Timpson NJ, Harbord RM, Leary S, Ness A, McCarthy MI, *et al*. Exploring the developmental overnutrition hypothesis using parental-offspring associations and FTO as an instrumental variable. PLoS Med 2008;5:e33.
13. Liu Y, Chen HJ, Liang L, Wang Y. Parent-child resemblance in weight status and its correlates in the United States. PLoS One 2013;8:e65361.
14. Agras WS, Hammer LD, McNicholas F, Kraemer HC. Risk factors for childhood overweight: A prospective study from birth to 9.5 years. J Pediatr 2004;145:20-5.
15. Muthuri SK, Onywera VO, Tremblay MS, Broyles ST, Chaput JP, Fogelholm M, *et al*. Relationships between parental education and overweight with childhood overweight and physical activity in 9-11 year old children: Results from a 12-country study. PLoS One 2016;11:e0147746.
16. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: International survey. BMJ 2000;320:1240-3.
17. Bennette C, Vickers A. Against quantiles: Categorization of continuous variables in epidemiologic research, and its discontents. BMC Med Res Methodol 2012;12:21.
18. Keane E, Layte R, Harrington J, Kearney PM, Perry IJ. Measured parental weight status and familial socio-economic status correlates with childhood overweight and obesity at age 9. PLoS One 2012;7:e43503.
19. Francis LA, Ventura AK, Marini M, Birch LL. Parent overweight predicts daughters' increase in BMI and disinhibited overeating from 5 to 13 years. Obesity (Silver Spring) 2007;15:1544-53.
20. He M, Evans A. Are parents aware that their children are overweight or obese? Do they care? Can Fam Physician 2007;53:1493-9.
21. Parkinson KN, Reilly JJ, Basterfield L, Reilly JK, Janssen X, Jones AR, *et al*. Mothers' perceptions of child weight status and the subsequent weight gain of their children: A population-based longitudinal study. Int J Obes (Lond) 2017;41:801-6.

22. Voelker DK, Reel JJ, Greenleaf C. Weight status and body image perceptions in adolescents: Current perspectives. Adolesc Health Med Ther 2015;6:149-58.
23. Schur EA, Sanders M, Steiner H. Body dissatisfaction and dieting in young children. Int J Eat Disord 2000;27:74-82.
24. Vanhala ML, Keinänen-Kiukaanniemi SM, Kaikkonen KM, Laitinen JH, Korpelainen RI. Factors associated with parental recognition of a child's overweight status – A cross sectional study. BMC Public Health 2011;11:665.
25. Parsons TJ, Power C, Logan S, Summerbell CD. Childhood predictors of adult obesity: A systematic review. Int J Obes Relat Metab Disord 1999;23 Suppl 8:S1-107.
26. Duran-Tauleria E, Rona RJ, Chinn S. Factors associated with weight for height and skinfold thickness in British children. J Epidemiol Community Health 1995;49:466-73.
27. Gulliford MC, Mahabir D, Rocke B, Chinn S, Rona R. Overweight, obesity and skinfold thicknesses of children of African or Indian descent in Trinidad and Tobago. Int J Epidemiol 2001;30:989-98.
28. Savage T, Derraik JG, Miles HL, Mouat F, Hofman PL, Cutfield WS, *et al.* Increasing maternal age is associated with taller stature and reduced abdominal fat in their children. PLoS One 2013;8:e58869.
29. Eriksen W, Sundet JM, Tambs K. Paternal age at birth and the risk of obesity in young adulthood: A register-based birth cohort study of Norwegian males. Am J Hum Biol 2013;25:29-34.
30. Matthiessen J, Stockmarr A, Fagt S, Knudsen VK, Biltoft-Jensen A. Danish children born to parents with lower levels of education are more likely to become overweight. Acta Paediatr 2014;103:1083-8.
31. Muthuri SK, Francis CE, Wachira LJ, Leblanc AG, Sampson M, Onywera VO, *et al.* Evidence of an overweight/obesity transition among school-aged children and youth in Sub-Saharan Africa: A systematic review. PLoS One 2014;9:e92846.
32. Pavela G. Is childhood socioeconomic status independently associated with adult BMI after accounting for adult and neighborhood socioeconomic status? PLoS One 2017;12:e0168481.
33. Duarte CS, Chambers EC, Rundle A, Must A. Physical characteristics of the environment and BMI of young urban children and their mothers. Health Place 2010;16:1182-7.
34. Kim SY, Sharma AJ, Callaghan WM. Gestational diabetes and childhood obesity: What is the link? Curr Opin Obstet Gynecol 2012;24:376-81.
35. Harder T, Roepke K, Diller N, Stechling Y, Dudenhausen JW, Plagemann A, *et al.* Birth weight, early weight gain, and subsequent risk of type 1 diabetes: Systematic review and meta-analysis. Am J Epidemiol 2009;169:1428-36.
36. Adamo KB, Brett KE. Parental perceptions and childhood dietary quality. Matern Child Health J 2014;18:978-95.
37. Yannakoulia M, Panagiotakos DB, Pitsavos C, Stefanadis C. Correlates of BMI misreporting among apparently healthy individuals: The ATTICA study. Obesity (Silver Spring) 2006;14:894-901.