

The mediating effect of parents' educational status on the association between adherence to the Mediterranean diet and childhood obesity: the PANACEA study

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Abstract

Objectives To investigate the potential mediating effect of parental education on the association between adherence to the Mediterranean diet and obesity, in 10–12 years old children.

Methods A cross-sectional survey was performed among 1,125 (529 male) children in Greece. Children and their parents completed standardized questionnaires, which evaluated parents' educational level and dietary habits. Body mass index was calculated and children were classified as normal, overweight or obese (IOTF classification). Adherence to the Mediterranean diet was assessed using the KIDMED score.

Results 27.7% of the children were overweight and 6.3% were obese; 12.3% of children reported high adherence to the Mediterranean diet. Multi-adjusted analysis, stratified by parental education, revealed that adherence to the Mediterranean diet was inversely associated with children's obesity status only in families in which at least one parent was of higher educational level (stratum-specific adjusted odds ratio: 0.41; 95% CI 0.17–0.98), but not those in which both parents were of low educational level.

Conclusions Parental education status seems to play a mediating role in the beneficial effect of Mediterranean diet on children's obesity status.

Keywords Obesity · Mediterranean diet · Parent education · Mediation · Overweight · Children

Introduction

Obesity has become a modern epidemic in the developed and in the developing world in late years, both in adulthood and in childhood. Recent studies have asserted prevalence of up to 34 % concerning obesity and 68 % for overweight and obesity combined for adults in the United States, while for children and adolescents aged 2–19 years the corresponding obesity prevalence was 16.9 %. Similar trends were also observed in Europe, and especially in the Southern regions (Raine 2012; Jackson-Leach and Lobstein 2006). Greece is a country which suffers the most from this current childhood epidemic, with almost 1 out of 3 children aged 10–12 years old being overweight and 1 out of 10 being obese (Farajian et al. 2011).

The etiology of childhood obesity is multi-factorial. Genetic, psychological and environmental factors are implicated in the complex pathophysiological mechanisms that contribute to the over-accumulation of fat in the human body, which has been found to be related to a number of pathologies in the adult life, such as metabolic syndrome, diabetes mellitus and cardiovascular diseases (Marques-Vidal et al. 2012). Environmental factors are vastly researched due to the possibility of their modification to reverse or to prevent the onset of childhood obesity. Nutrition is one of the two key components—the other being physical activity—in the obesity equation and dietary patterns play a

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significant role. Since the early 1960s a rather unique dietary pattern, the Mediterranean diet, has been associated with lower prevalence of cardiovascular disease and diabetes mellitus as well as improved inflammatory marker profile in the adult population (Panagiotakos et al. 2007; Esposito et al. 2006). As far as childhood obesity is concerned, the effect of the Mediterranean diet has not been thoroughly explained. Schröder et al. (2010) have reported that adherence to the Mediterranean diet reduced the risk of increased waist circumference among Spanish children and young adults. Such diet was also associated with a higher number of daily meals per day and better nutrient knowledge scores, indicating a healthier diet profile (Sahingoz and Sanlier 2011). However, there are a number of studies with a non-significant or very weak association between the Mediterranean diet and body mass index (BMI—an anthropometric index of adiposity) that was revealed (Jennings et al. 2011; Kontogianni et al. 2008). Furthermore, parental education status has been suggested to be an additional factor that influences childhood overweight or obesity. Specifically, higher educational level of the parents has been negatively associated with their offspring's weight status (Gopinath et al. 2012) and has been related to higher adherence to the Mediterranean diet (Martinez et al. 2010). It has also been reported that genetic and environmental influences, like dietary habits, on BMI could be modified by parental education in children and adolescents (Lajunen et al. 2012).

However, there is lack of evidence in the literature regarding a potentially mediating effect of parents' education to the association between the Mediterranean dietary pattern and the BMI category of their children. Thus, the aim of the present work was to evaluate the aforementioned joint effect of parental education and adherence to the Mediterranean diet on the obesity status of Greek school-children aged 10–12 years old, who participated in the PANACEA epidemiological study.

Methods

Study sample

The sampling procedure of the extended PANACEA (Physical Activity, Nutrition and Allergies in Children Examined in Athens) study took place during 2005–2009 (Priftis et al. 2007). Overall, 1,125 school children (boys and pre-menstrual girls) aged from 10 to 12 years were voluntarily enrolled in the study; of these 700 students were selected from 18 schools located in the greater Athens area, while the additional 425 selected were enrolled from two rural areas (300 students from 7 schools located in the Iliia county and 125 students from 3 schools located in the Viotia county). The schools were randomly selected from a

list provided by the regional education offices. The sampling was equally distributed between September and May for all areas and the overall participation rate was 83.5 %.

The total number of enrolled children ($n = 1,125$) was calculated to be adequate to evaluate odds ratios between various groups of study equal to 1.20, at probability level <0.05 and achieving statistical power equal to 77 % (G-Power free software, Kiel University, Germany).

The study has been designed according to the principles of the declaration of Helsinki (1989). The protocol of the study has been approved by the Education Institute of the Hellenic Ministry of Education (approval 29712/G7/2006). To enroll a child in the study, their parents or guardians were informed about the objectives and methods of the study and signed an informed consent; participating children provided their verbal assent.

Measurements

Evaluation of socio-demographic, anthropometric and lifestyle characteristics

The questionnaire developed for the purposes of the PANACEA study used to gather information about age, sex, school class, region of living (urban or rural), dietary habits and physical activity status of the children, as well as living in their own bedroom (yes/no). Parental educational level was also assessed separately for the mothers' (maternal) and fathers' (paternal) of the children with a question about years of school, reflecting the highest level in the educational system that a parent had attended (i.e., high: >15 years = academic educational level/tertiary education, like Universities or Technological Educational Institutes, as well as postgraduate studies, moderate: 9–12 years = secondary education, which is offered by the Lyceums and Technical Vocational Educational Institutes, and low: <9 years = basic educational level, like compulsory primary and secondary education). Moreover, number of automobiles per family, parental smoking habits (yes/no) and breastfeeding (yes/no), was also recorded. The questionnaires were administered to the participating children and completed by their parents at home; then, they were delivered to the study's investigators by the children's school teacher. Height and weight were measured at school setting, following standard procedures and children's BMI was calculated to classify them as normal weight and overweight or obese, using the IOFT (International Obesity Task Force) classification (Cole et al. 2000). These cut-off points are based on health-related adult definitions of overweight (≥ 25 kg/m²) and obesity (≥ 30 kg/m²), but are adjusted to specific age and gender categories for children. Standing height was measured to the nearest 0.1 cm with a Raven Minimater (Raven Equipment Limited, Essex,

United Kingdom) after children had removed their shoes and body weight was measured to the nearest 0.1 kg on calibrated digital scales (Seca, Hanover, MD), after children removed their heavy clothes. Children's parents also reported their weight and height, which was used to calculate their BMI and to classify them also as normal weight, overweight and obese, according to the standard adult BMI cut off points.

Participated children completed a validated, semi-quantitative food frequency questionnaire (FFQ) that was administered, with their parents' help, when required. Information about the frequency of consumption of 63 foods and beverages usually consumed in Greece, as well as other dietary habits and behaviors (i.e., eating breakfast, meals' frequency per day), was recorded. Typical serving sizes of the above food and beverages were used as standard units for measurements. The FFQ used here has been found valid as compared with a 3-day dietary diary for use in the nutritional assessment of Greek children aged 10–12 years [Bland and Altmans' bias (i.e., difference between the FFQ and the gold standard 3-day diary) was close to zero, and ranged between 0.19 servings/day for sweet/snacks and 1.32 servings/day for starchy products food groups (Antonogeorgos et al. 2011)]. Adherence to the Mediterranean diet was evaluated using the KIDMED index (Mediterranean diet quality index for children and adolescents) that was administered to the children together with the FFQ (Serra-Majem et al. 2004). Dietary habits with positive aspect to the Mediterranean diet, such as having a dairy product or cereals or grains for breakfast, scored with +1 and dietary habits with negative association with Mediterranean diet, not eating fruits and vegetables, scored with -1. The theoretical total score ranges from -4 to 12 and it divided into two categories: ≥ 8 , high adherence to the Mediterranean diet; and ≤ 8 , moderate or low adherence to the Mediterranean diet.

The study's questionnaire also included questions about the frequency and duration (in hours) of physical (like leisure time and sports activities) and sedentary (like watching television, working on a computer, playing video games) activities. Children were classified as non-active if their mean energy expenditure per day was less or equal to $37 \text{ kcal kg}^{-1} \text{ day}^{-1}$. The physical activity section of the questionnaire has been previously validated by the Department of Physical Education, of the Democritus University of Thrace and was found to be a reliable and valid instrument for the estimation of physical activity in children (Argiropoulou et al. 2004).

Statistical analysis

All continuous variables are presented as mean \pm standard deviation (SD) and all the categorical variables are presented as frequencies and percentages. Associations

between categorical variables were assessed using the Chi-square test and comparisons between mean values were evaluated using the *t* test, after checking for the normality of the distributions or Mann–Whitney test, where appropriate. To assess the relationship between overweight and/or obesity and adherence to the Mediterranean diet, multiple logistic regression analysis was applied, after adjusting for various factors that were considered “a priori” as potential confounders (i.e., urban/rural factors, parental obesity status) based on bibliographic evidence (McCrary and Layte 2012; Farajian et al. 2012; Antonogeorgos et al. 2012; Haug et al. 2009; Lazarou and Kalavana 2009). To test for the potential mediating effect of parental educational level on the association between KIDMED and childhood obesity, the analysis of two logistic models was applied, one without (crude model) and one with an interaction term (the product term of the multiplication between the two exposure variables (KIDMED and parental education). Likelihood ratio test was used to compare the fit of the interaction term model in relation to the crude one. Statistical significant results indicated an significant modification effect between the two under-study variables. Results of the logistic regression models were presented as odds ratios (OR) and their corresponding 95 % confidence intervals (CI). Hosmer–Lemeshow statistic was calculated to evaluate model's goodness-of-fit. All reported probability values (*p*-values) were based on two-sided hypotheses and compared to a significant level of 5 %. STATA 11 software was used for all the calculations (Stata Corp., 2011, College Station, TX, USA).

Results

Overall, 27.7 % of the children were overweight, 6.3 % were obese and 12.3 % of the children had high adherence to the Mediterranean diet (i.e., KIDMED score > 8). More than half of the children (50.6 %) had at least one parent with higher educational status and among them 26.5 % had both academic educated parents.

In Table 1 various characteristics of the children are presented according to their paternal, maternal and parental educational status. Children who were raised in families which had at least one low educated parent were more likely to be overweight or obese ($p = 0.02$). Higher adherence in the Mediterranean dietary pattern was observed in children whose fathers had high educational background ($p = 0.04$). Frequency eating patterns related to less overweight or obesity in childhood like daily breakfast consumption during the week and increased meal frequency consumption per day were also associated with higher maternal and paternal educational status ($p = 0.05$ and $p < 0.001$, respectively). Regarding the association

Table 1 Socio-demographic and lifestyle characteristics of 10- to 12-year-old children according to their maternal, paternal and parental educational status (low vs. high) living in urban (Athens) and rural areas (Viotia and Ilia) in Greece during 2005–2009

	Maternal low/moderate educational level	Maternal high educational level	<i>p</i>	Paternal low/moderate educational level	Paternal high educational level	<i>p</i>	Both parents with low/moderate educational level	At least one parent with high educational level	<i>p</i>
<i>N</i>	623	419		656	398		589	536	
Physically active, %	57.9	58.7	0.81	57.9	58.3	0.97	56.7	59.3	0.37
Obesity, %	6.2	6.5	0.31	6.2	6.6	0.05	6.8	5.8	0.02
Overweight, %	26.4	30.9		25.4	32.8		23.6	32.0	
KIDMED score (0–12)	4.8 ± 2.0	4.9 ± 1.9	0.79	4.8 ± 1.9	5.0 ± 2.0	0.04	4.9 ± 2.0	5.0 ± 2.1	0.74
KIDMED score >8, %	9.3	7.4	0.28	8.1	9.3	0.50	8.2	15.9	<0.001
Daily breakfast consumption, %	59.6	65.2	0.05	57.3	68.9	<0.001	56.9	66.5	0.001
>3 meals/day, %	57.4	65.9	0.003	56.2	67.4	0.001	54.1	66.4	<0.001
Own bedroom, %	71.9	80.3	0.002	74.6	76.6	0.48	72.5	77.9	0.04
Leisure time, hours/week	2.3 ± 2.1	1.6 ± 1.6	<0.001	2.2 ± 2.1	1.8 ± 1.8	0.02	2.3 ± 2.2	1.8 ± 1.8	<0.001
Sport activities, hours/week	3.2 ± 2.7	3.9 ± 3.3	0.001	3.3 ± 3.0	3.9 ± 3.1	0.005	3.1 ± 2.8	3.8 ± 3.2	<0.001
Rural living area, %	48.0	26.3	<0.001	44.5	29.7	<0.001	44.7	30.2	<0.001
>1 vehicle/family, %	48.4	62.9	<0.001	48.3	62.7	<0.001	46.7	61.1	<0.001

Statistics are mean value ± standard deviation. *P*-values were derived from *t*-tests after controlling for the normality of the distributions and Chi square-tests

between family's socio-economic status (SES) indices and parental educational level, more children with their own bedroom and children living in a family owning more than one vehicles had higher educated mothers or had families with at least one parent with tertiary education (all *p*-values <0.05). Rural residency was more frequent among families of which both parents had compulsory and secondary, but not academic education (all *p*-values <0.001).

Children with low adherence to the Mediterranean diet were more likely being overweight or obese, (60.3 vs. 45.9 %, *p* = 0.002). Moreover, families whose children were close to the Mediterranean diet were more likely to have at least one parent of higher educational level, and were less likely for either of the parents to be smokers; also, it was more likely for mothers to have breastfed their children (Data not shown).

Further analysis revealed that children with higher adherence to the Mediterranean diet were 25 % less likely to be overweight or obese. The potential confounding effect of parental education status on the aforementioned relationship was then tested (Table 2). The effect of dietary habits on obesity status was neither significant nor showed any substantial change in the estimated ORs between the model without the inclusion of the parental educational status (model 1) or the fully adjusted model with the inclusion of it (model 2). However, a strong interaction between children's adherence to the Mediterranean diet level and parental education status on obesity status was

revealed (Table 3, *p* for interaction = 0.03). Thus to examine the potential mediating effect of parental education in the association of the diet with childhood obesity, a stratified analysis according to the educational level of the parents was applied. In Table 3, the results of the aforementioned analyses are presented. Among children with both parents of low/moderate educational level, adherence to the Mediterranean diet was not related to their overweight or obese status, after adjusting for age, sex, physical activity, breastfeeding, daily breakfast consumption, frequent meal consumption and parental obesity status (adjusted odds ratio (aOR) 1.30, 95 %CI 0.64–2.64). In contrast, among children with at least one parent with high educational status, higher adherence to the Mediterranean diet was associated with lower likelihood of being overweight or obese (aOR 0.41, 95 %CI 0.17–0.98), after adjusting for all the previously mentioned confounders.

Discussion

To the best of our knowledge, this is the first study that assessed the joint effect of adherence to the Mediterranean diet and parental level of education on childhood obesity. Parent's academic level was associated with lower overweight or obesity levels and improved adherence to the Mediterranean diet. In addition, higher parental education was associated with a healthier lifestyle and dietary profile, as indicated by the increased time devoted to sports

Table 2 Results from multiple logistic regression analysis that evaluated the role of adherence to the Mediterranean diet (main effect) on obesity status (outcome) of $n = 1,125$, 10- to 12-year-old children living in urban (Athens) and rural areas (Viotia and Ilia) in Greece, during 2005–2009

	Model 1 odds ratio (95% CI)	Model 2 odds ratio (95% CI)
Age, per 1 year	0.79 (0.65–0.97)	0.80 (0.66–0.98)
Boys vs. girls	1.74 (1.30–2.33)	1.76 (1.32–2.35)
County (rural vs. urban)	0.72 (0.53–0.97)	0.75 (0.55–1.02)
KIDMED score, High vs. low/moderate	0.77 (0.45–1.29)	0.76 (0.45–1.29)
Active vs. inactive children	0.94 (0.70–1.60)	0.92 (0.69–1.24)
History of breastfeeding, yes vs. no	1.06 (0.71–1.60)	1.04 (0.69–1.24)
Daily breakfast consumption, yes vs. no	0.84 (0.62–1.13)	0.82 (0.61–1.11)
Consumption of >3 meals per day, yes vs. no	0.88 (0.62–1.13)	0.85 (0.69–1.07)
At least one parent overweight or obese, yes vs. no	0.88 (0.70–1.09)	1.62 (1.19–2.21)
At least one parent with higher educational level, yes vs. no	–	1.28 (0.95–1.72)

activities, as well as the higher prevalence of daily breakfast consumption and the increased frequency of meal consumption per day. One of the main findings of this work was that higher adherence to the Mediterranean diet was associated with lower likelihood of overweight/obesity, only among children with at least one parent of higher education, while for the children coming from families with both parents of low or moderate educational level the effect was not significant. The observation that adherence

to the Mediterranean diet was associated with fewer hours of sedentary lifestyle and more frequent breastfeeding, profiling also a healthier lifestyle pattern, was taken into account as regards the aforementioned relationship and the protective effect of the Mediterranean diet on children's body mass status only within families with at least one parent of higher education, remained significant.

Lower level of parental education, as a proxy of low SES, has been previously documented as an established risk factor for childhood obesity (Hesketh et al. 2007; Moschonis et al. 2010). However, this association has not emerged as consistently significant throughout the relevant literature. There are studies reporting evidence ranging from no significant association between SES and obesity status, up to even strong positive relationship between higher SES with adiposity in children, with great variation of the significance and the direction of the SES effect on children's overweight or obesity in various age groups (Patel et al. 2011; Wijlaars et al. 2011). The pathways relating parental education with childhood obesity are still unknown, but the difference between cultural and social characteristics could provide possible explanation. Parents of higher educational level may be more alarmed by their children's weight and more informed about the importance of physical activity and healthy dietary patterns, which results in providing their children with more opportunities for adopting a healthier lifestyle (Hesketh et al. 2007). Moreover, it could be argued that they are more likely to have a better financial status than low educational level parents, thus, allowing them to afford a better diet quality and to support financially the physical activity of the children's choice (Hesketh et al. 2007). In addition, families with low-educated parents are more likely to reside in

Table 3 Results from multiple logistic regression analysis that evaluated the role Mediterranean diet (main effect) on obesity status (outcome) of $n = 1,125$, 10- to 12-year-old children living in in urban

(Athens) and rural areas (Viotia and Ilia) in Greece, during 2005–2009, according to the parental educational level (mediator)

	Children living in families with both parents of low/moderate educational level ($n = 589$)		Children living in families with at least one parent of high educational level ($n = 536$)	
	Odds ratio	95 % CI	Odds ratio	95 % CI
Age, per 1 year	0.75	0.57–1.00	0.85	0.63–1.15
Boys vs. girls	1.60	1.06–2.41	1.97	1.29–3.02
County (rural vs. urban)	0.71	0.46–1.11	0.78	0.51–1.21
KIDMED score, High vs. low/moderate	1.30	0.64–2.64	0.41	0.17–0.98
Active vs. inactive children	1.10	0.72–1.67	0.72	0.47–1.12
History of breastfeeding, yes vs. no	0.45	0.24–0.85	0.64	0.42–0.99
Daily breakfast consumption, yes versus no	1.06	0.68–1.64	0.64	0.42–0.99
Consumption of >3 meals per day, yes vs. no	0.76	0.54–1.08	0.94	0.69–1.28
At least one parent overweight or obese, yes vs. no	1.51	0.97–2.35	1.91	1.21–3.01

p for the interaction between KIDMED score and parental education = 0.03

low SES neighborhoods, which have been linked with less accessibility and activities as walking and higher rates of overweight and obesity in preschool girls and school-aged children (Spence et al. 2008; Prince et al. 2012).

In the present work, the protective effect of the Mediterranean diet with childhood obesity was modified, but not confounded, by parental education status, since it was restricted only to the families with at least one highly educated parent. These findings expand earlier results by Kontogianni et al. (2008) who reported higher KIDMED scores in children with a mother or a father with higher education. A number of studies support that children's quality of diet is influenced independently by the effect of family educational status (Wachs et al. 2005; Serra-Majem et al. 2002). The parental influence on children's food choices through the food availability and accessibility could also explain the enhanced effect of Mediterranean diet on childhood obesity for at least one highly educated parent families (Cullen et al. 2003). Also parents, through their own eating habits, are acting as role-models for their offspring, thus parents with healthier eating pattern could positively affect their children's eating habits (Fisher et al. 2002). Moreover, higher academic level may be related to higher knowledge of the benefits of the Mediterranean diet to health. Finally, higher family academic status may also be associated to higher income and subsequently to better availability of the choice of healthier foods, like fruits, vegetables, whole grain products, fish and seafood that comprise important parts of the Mediterranean diet pyramid, instead of junk food that is usually less expensive.

The Mediterranean diet is a dietary pattern which has been documented as a protective factor against obesity and cardiovascular risk in adults for many years (Bonaccio et al. 2011; Romaguera et al. 2009). However, there is no clear evidence of this association in childhood. In the study of Schröder et al. (2010) a negative association was reported between increased waist circumference, as a proxy for abdominal fat mass, and adherence to the Mediterranean diet (using the KIDMED diet score) in a representative sample of Spanish children and young adults. The authors attributed this association of two individual components of the Mediterranean diet, namely the higher intakes of fruits and vegetables (Schroder 2007) and supported their findings by the study of Ritchie et al. (2007) who also reported an inverse association between consumption of fruits and vegetables with waist circumference in female adolescents. In contrast, in the studies by Farajian et al. (2011) and Jennings et al. (2011) no significant relationship was found, suggesting an independent association between Mediterranean diet with better diet quality and healthier lifestyle patterns, but without any effect on children's weight. Both studies, however, have not taken into account the possible

accumulative effect of parental education in their multi-adjusted analyses.

It should be noted, that the PANACEA study is a cross-sectional survey and, therefore, cannot establish causal relationships, due to the phenomenon of potential reverse causality; its findings can only be used to state hypotheses. However, it is more likely that Mediterranean dietary eating pattern could be affecting obesity status as well as dietary habits may be influenced by parental education than vice versa and effort was put to avoid overgeneralization of our results (Dattilo et al. 2012). Furthermore, no other anthropometric indices were measured (like fat-free mass or multisite skinfold thickness); however, BMI classification has high accuracy in both sexes in estimating excess weight compared with other criteria and correlates well with multisite skinfold thickness.

Conclusions

Children obesity is a major challenge for public health nowadays. The dramatic increase of the number of children, who are overweight or obese around the world, emerges the need for actions (Kosti and Panagiotakos 2006). Healthy diet seems to be a promising, and relatively inexpensive mean against childhood obesity. The results of the present study revealed that high adherence to the Mediterranean diet by children living in families with at least one parent of high academic level, but not both parents of low or moderate education level, may offer protection against childhood obesity. The understanding of the complex pathways relating diet to the prevention of childhood obesity is of crucial importance, and parental education level could mediate the protective effect of Mediterranean diet. More large, prospective cohort studies are needed to further elucidate the role of parental education in childhood obesity. In the meantime, effort should be put to allow low educated parents to gain more knowledge about healthy lifestyles and dietary patterns, which will further promote the Mediterranean diet.

Conflict of interest The authors declare that they have no conflict of interest.

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