Correlates of childhood obesity in Athens, Greece

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Abstract

Objective: Childhood obesity is a growing public health problem. We have examined the association between sociodemographic profile and eating and physical activity patterns with overweight among primary-school students in Athens, Greece.
Design: Cross-sectional study.
Setting: Eleven primary schools in the greater Athens area, Greece.
Subjects: A total of 633 children aged 10–12 years (50% boys, 50% girls) were interviewed in person during spring 2003. Multivariate logistic regression was used to investigate the association between eating and physical activity patterns and overweight ($\geq$85th sex- and age-specific BMI centile). Results are presented as odds ratios and 95% confidence intervals.
Results: Overweight was more common among girls than among boys (OR = 1·73; 95% CI 1·11, 2·69) and substantially less common among children born outside Greece (OR = 0·46; 95% CI 0·22, 0·95). Reported physical activity (per 1·5 h per day) was unrelated to overweight (OR = 0·97; 95% CI 0·85, 1·12) but patent physical inactivity, operationalised as time spent watching television or working/playing with the computer (per 1·5 h per day) was a highly significant predictor of overweight (OR = 1·20; 95% CI 1·05, 1·36). Composition of diet was unrelated to overweight but the daily number of eating occasions, controlling for total energy intake, was significantly inversely associated with overweight (OR = 0·61; 95% CI 0·48, 0·76).
Conclusions: The principal factor underlying overweight among children in Athens appears to be the extended inactivity imposed by modern childhood lifestyles. An intriguing finding is that spreading a given energy intake over several eating occasions was inversely associated with the likelihood of childhood obesity.

Overweight and obesity are important risk factors for several diseases including CVD and cancer[1,2]. Since the latency of many chronic diseases is long and several lifestyle patterns are established in childhood and adolescence, the prevalence of overweight and obesity and their determinants during these stages of life are important public health issues. Several studies have documented that the prevalence of obesity in childhood and adolescence in several European countries is high and increasing[3,4] and the problem is particularly evident in Greece[5–8]. We report here the results of a cross-sectional study on correlates of overweight undertaken among pre-adolescent primary-school children in the capital city of Greece, Athens.

Methods

In January 2003, an interviewer-administered questionnaire was developed to ascertain sociodemographic profile, dietary patterns and physical activity of 5th and 6th grade primary-school pupils in Athens, Greece. Under the guidance of the lead author of this study, the questionnaire was discussed among the five students of the Health Visiting Unit of Athens Technological Educational Institute who would act as the interviewers. Then, each of the interviewers, in turn, submitted the questionnaire to his/her remaining four colleagues, in order to achieve a high degree of clarity and repeatability. Between March 2003 and June 2003, the questionnaire was distributed by the five trained interviewers to eleven primary schools dispersed in the Greater Athens area. The schools were chosen to represent the spectrum of schools in the Athens area. Although a small but not recorded number of pupils were not present at the visit of the interviewers, virtually all present volunteered to fill in the questionnaire and only six questionnaires were judged incomplete. Height and weight were measured at the same time as the interviews, with sets of five SECA 220 stadiometers and five SECA Bellissima 841 scales, respectively. All instruments were calibrated, regularly checked and adjusted when needed. Measurements were

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carried out by the trained investigators while the pupils were lightly dressed and without shoes and their BMI was calculated in kg/m². Subsequently, growth charts developed for Greek children by the First Department of Pediatrics of Athens University Medical School were used in order to identify who among the examined children had a BMI equal to or above the 85th centile in the corresponding age and gender BMI curve[9].

The questionnaire included entries concerning year and place of birth, birth order, paternal education (an indicator of socio-economic status) and a detailed FFQ that included 25 food item categories generally consumed by pre-adolescent boys and girls in Greece. The questionnaire was comprehensive enough to allow calculation of energy intake as well as protein, carbohydrate and lipid intake on the basis of food composition tables for Greece[10]. The FFQ was based on the one used in a series of case–control studies conducted in Greece by the Department of Hygiene and Epidemiology of the University of Athens' Medical School. This questionnaire has not been formally validated but the results of these studies have been in line with those of major nutritional epidemiology investigations previously or subsequently undertaken[11,12]. The questionnaire also had entries allowing the calculation of hours per day of vigorous physical activity (sports, bicycling, swimming, gymnastics) as well as hours of essential inactivity excluding sleep (watching television or working/playing with the computer)[13]. No formal validation of this questionnaire was undertaken.

For the statistical analysis, the study subjects were cross-classified by gender, overweight (≥85th or <85th centile) and the indicated principal study variables. Subsequently, the data were modelled through multiple logistic regression using as outcome overweight (≥85th centile) v. else (<85th centile). All covariates indicated in the tables were mutually adjusted for, except for carbohydrates, in order to avoid collinearity, since total energy intake as well as energy from protein and from total fat were included in the model. The SPSS 12.0 Statistical Software Package (SPSS Inc., Chicago, IL, USA) was used.

Results

Complete questionnaires were available for a total of 633 pupils (316 boys, 317 girls). Table 1 compares the distributions of normal weight (<85th centile) and overweight (≥85th centile) boys and girls by age, place of birth, birth order, marital status of parents, paternal education (the most important indicator of socio-economic status in Greece), number of eating occasions, frequency of consumption of refreshments (including juices and sodas), conditions surrounding eating (eating under parental pressure), hours of physical activity per day (gymnastics, group sports, bicycling, swimming, etc.) and hours of inactivity per day except sleep (time spent on television

and/or computer). Daily intake (median, 25 and 75 centiles) of energy overall and of energy-generating nutrients are also shown.

The data in Table 1 serve only descriptive purposes because they do not accommodate possible mutual confounding. Nevertheless, there is evidence that overweight is more common among girls than among boys, among children of parents who do not live together and among children with patent inactivity, whereas overweight is less common among children born outside Greece and among children who distribute their energy intake among many, rather than few, eating occasions. The energy intake data in this table suggest that there are no strong associations between energy intake, overall or from specific macronutrients, on the one hand, and overweight on the other, among either boys or girls. About 15% of energy intake was derived from proteins, about 35% from carbohydrates and about 50% from lipids.

Table 2 shows mutually adjusted odds ratios and 95% confidence intervals for overweight v. normal weight by specified contrasts or increments of the indicated predictor variables. The probability of overweight is significantly higher among girls than among boys and significantly lower among foreign-born children. Children of separated parents are significantly and considerably more likely to be overweight, although the numbers are small. Controlling for total energy intake, children spreading their intake over several occasions (larger number of daily eating episodes) have significantly lower prevalence of obesity. Neither reported total energy intake nor qualitative aspects of diet, including consumption of beverages, appear to be related to overweight among children in this data set. Reported physical activity is also unrelated to overweight. In contrast, physical inactivity is strongly and significantly related to overweight, so that an additional 1·5 h of inactivity is associated with a 20% increase in the prevalence of overweight. There was a borderline significant ($P = 0·06$) inverse association between parental pressure and overweight.

Discussion

We have undertaken a cross-sectional investigation of 633 school children in the last two years of their studies in eleven primary schools in variable socio-economic areas of Athens and have defined as overweight children those whose BMI exceeded the 85th centile of the corresponding age-, gender- and height-specific distribution. We have studied the independent predictors of overweight through multiple logistic regression. Overweight was more common among girls than among boys and substantially less common among children born outside Greece. Reported physical activity was unrelated to overweight but patent physical inactivity, operationalised as time spent watching television or working/playing

Table 1 Sociodemographic, lifestyle and diet characteristics of 633 primary-school students in Athens, Greece*

	Boys (n 316)				Girls (n 317)			
	<85th centile (normal)		≥85th centile (overweight)		<85th centile (normal)		≥85th centile (overweight)	
Variable	n	%	n	%	n	%	n	%
Age (years)								
<11	162	60·2	30	65·2	148	61·2	46	61·3
12+	107	39.8	16	34.8	94	38.8	29	38.7
Place of birth								
Athens	192	71·4	40	87·0	191	78·9	62	82·7
Rural	24	8·9	4	8·7	16	6·6	4	5·3
Abroad	53	19·7	2	4·3	35	14·5	9	12·0
Birth order								
1	121	45·0	23	50·0	134	55·4	42	56·0
2+	148	55·0	23	50·0	108	44·6	33	44·0
Marital status of parents								
Living together	261	97·0	42	91·3	224	92·6	65	86·7
Separated	8	3·0	4	8·7	18	7·4	10	13·3
Paternal education								
Primary school	43	15·8	6	13·0	43	17·6	11	14·9
High school	65	24·2	8	17·4	42	17·2	21	28·4
Lyceum	100	37·4	18	39·1	84	34·9	18	24·3
University	61	22·6	14	30·4	73	30·3	25	32·4
No. of eating occasions								
≤2	12	4·5	3	6·5	22	9·1	15	20·0
3	65	24·2	22	47·8	52	21·5	18	24·0
4	125	46·5	18	39·1	97	40·1	31	41·3
5+	67	24·9	3	6·5	71	29·3	11	14·7
Frequency of consumption for refreshments								
Never–rarely	14	5·2	6	13·0	24	9·9	8	10·7
1–2 times/d	128	47·6	22	47·8	147	60·7	41	54·7
3–4 times/d	62	23·0	9	19·6	35	14·5	12	16·0
5+ times/d	65	24·2	9	19·6	36	14·9	14	18·7
Eating under pressure								
No	159	59·1	33	71·7	133	55·0	45	60·0
Sometimes	85	31·6	10	21·7	80	33·1	26	34·7
Yes	25	9·3	3	6·5	29	12·0	4	5·3
Energy intake (kcal/d)								
Median	2071·0		1902·6		2052·6		1899·8	
25th centile	1619·0		1479.3		1597.0		1366.5	
75th centile	2670·4		2624·1		2552·6		2299·3	
Protein intake (kcal/d)								
Median	299·3		289·2		295·2		269·8	
25th centile	228·0		185·6		213·2		189·7	
75th centile	386·0		377·9		375·8		337·5	
Carbohydrate intake (kcal/d)								
Median	741·7		686·6		717·6		603·4	
25th centile	567·1		449·2		555·1		431·4	
75th centile	970·5		1030·0		891·3		819·9	
Fat intake (kcal/d)								
Median	1085·5		1027·3		1086·9		1027·2	
25th centile	807·5		702·7		795·9		752·1	
75th centile	1394·9		1443·3		1405·7		1272·3	
Physical activity (h/d)								
≤2	84	31·2	12	26·1	111	45·9	36	48·0
3–4	147	54·6	24	52·2	113	46·7	36	48·0
4+	38	14.1	10	21·7	18	7·4	3	4·0
Television/computer use (h/d)								
≤2	122	45·4	18	39·1	158	65·3	44	58·7
3–4	125	46·5	22	47·8	69	28·5	27	36·0
5+	22	8·2	6	13·0	15	6·2	4	5·3

* Numbers and percentages; for one boy, height was not available and BMI could not be calculated.

with the computer, was a highly significant predictor of overweight. Composition of diet (energy from protein, carbohydrates and lipids) was unrelated to overweight but the daily number of eating occasions, controlling for total energy intake, was significantly inversely associated with overweight. There was evidence that separation of parents was an underlying cause of overweight.

Excess BMI among girls is a common finding among peri-adolescent girls in comparison to boys of the same age[14–18] and our finding in this context is in line with the

Table 2 Mutually adjusted odds ratios and 95 % confidence intervals for overweight *v.* normal weight by specified contrasts or increments of the indicated predictor variables

Predictor variables	Categories or increments	Odds ratio	95 % CI	*P* value
Sex	0, boys (baseline)			
	1, girls	1·73	1·11–2·69	0·02
Age	Per year	0·83	0·61–1·14	0·24
Birth place	Athens (baseline)			
	Else in Greece	0·87	0·38–1·98	0·73
	Abroad	0·46	0·22–0·95	0·04
Birth order	First (baseline)			
	Other	0·84	0·55–1·29	0·44
Parental marital status	Together (baseline)			
	Separated	2·65	1·23–5·69	0·01
Paternal education	Per about 5 years	1·12	0·91–1·38	0·25
Daily eating occassions	Per one	0·61	0·48–0·76	$<10^{-3}$
Daily consumption of beverages	Per one	1·02	0·87–1·19	0·84
Energy overall	Per 100 kcal	0·95	0·85–1·06	0·37
Energy from protein*	Per 100 kcal	0·87	0·58–1·30	0·50
Energy from fat*	Per 100 kcal	1·11	0·96–1·29	0·16
Parental pressure for eating	No, occasionally, yes (ordered)	0·72	0·51–1·011	0·06
Physical Activity	Per about 1·5 h per day	0·97	0·85–1·12	0·68
Inactivity except sleep	Per about 1·5 h per day	1·20	1·05–1·36	0·01

*Energy from carbohydrates was not included in the model in order to avoid collinearity.

literature. Children born abroad are mostly children of economic migrants of low socio-economic status. These children may be less exposed to the pressure of eating that permeates the Greek society. Children of separated parents, virtually all of them of native Greek parents, tend to be substantially more frequently overweight. This could be due to the fact that parental separation can generate an adverse psychological environment. Over-eating and overweight are common manifestations of psychological stress at various stages of life[19–21].

As in other epidemiological investigations, we found no association of overweight with total energy intake, a null finding which may be due, at least in part, to the fact that overweight persons tend to underestimate their dietary intakes[22]. In our study, about 15 % of energy intake was derived from proteins, about 35 % from carbohydrates and about 50 % from lipids. High intake of fat, largely in the form of olive oil, has been reported in many studies in the Greek population, among adults as well as among children[12,23–25]. The possible relationship of composition of diet with overweight is a controversial topic. Some authors have reported that controlling for energy intake, consumption of lipids is associated with increased BMI[26], whereas other studies have found no important association[27,28]. Among children, there have been reports that foods of animal origin may be associated with overweight[29–32] but the evidence remains inconclusive. Our results do not provide strong support for differential associations of distinct macronutrients with overweight, but power limitations do not allow exclusion for such a possibility. An intriguing finding that has also been reported by other investigators in studies among both adults[33,34] and children[35,36] is that controlling for total energy intake, spreading dietary intake over several eating occasions may impede weight gain. The underlying physiology of

such an association, however, is not clear, which clouds the biomedical plausibility of the finding[37].

Controlling for energy intake, an inverse association between physical activity and BMI (and overweight) should be expected on the basis of laws of physics. The empirical evidence, however, is less clear-cut, mainly because exposure ascertainment is difficult and non-differential misclassification extensive[13]. In our study, the low tail of activity, that is patent inactivity (times spent in television or computer), is probably better assessed and this explains the clear and statistically significant positive association between inactivity and overweight. The suggestive inverse association between parental pressure and overweight probably reflects reverse causation, since overweight children are less likely to receive parental pressure for eating.

Strengths of this investigation are ascertainment of overweight children on the basis of standardised curves, the sample selection from schools chosen to represent parts of Athens of different socio-economic status and the high participation rates. We did not attempt international comparisons that would have necessitated the use of the international Cole criteria[38], but the application of standardised BMI curves for Greek children allowed control of growth pattern. The study was of moderate size but there was enough statistical power for the documentation of several findings. Limitations of the study are lack of formal validation of the physical activity questionnaire and restriction of the sample to the urban population of Athens.

In conclusion, we have found evidence that the principal factor associated with overweight among children in Athens, and inferentially in Greece, is the extended inactivity imposed by the modern childhood lifestyle. This lifestyle involves prolonged watching of television

and working and playing on computer. An intriguing finding that has been previously reported but still needs further investigation is that spreading energy intake over several eating occasions was inversely related to childhood obesity.

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References

1. Kopelman PG (2000) Obesity as a medical problem. *Nature* **404**, 635–643.
2. Adami HO & Trichopoulos D (2003) Obesity and mortality from cancer. *N Engl J Med* **348**, 1623–1624.
3. Flodmark CE, Lissau I, Moreno LA & Pietrobelli A (2004) New insights into the field of children and adolescents' obesity: the European perspective. *Int J Obes Relat Metab Disord* **28**, 1189–1196.
4. Kosti RI & Panagiotakos DB (2006) The epidemic of obesity in children and adolescents in the world. *Cent Eur J Public Health* **14**, 151–159.
5. Mamalakis G, Kafatos A, Manios Y, Anagnostopoulou T & Apostolaki I (2000) Obesity indices in a cohort of primary-school children in Crete: a six year prospective study. *Int J Obes Relat Metab Disord* **24**, 765–767.
6. Krassas GE, Tzotzas T, Tsametis C & Konstantinidis T (2001) Prevalence and trends in overweight and obesity among children and adolescents in Thessaloniki, Greece. *J Pediatr Endocrinol Metab* **14**, Suppl. 5, S1319–S1326.
7. Magkos F, Manios Y, Christakis G & Kafatos AG (2006) Age-dependent changes in body size of Greek boys from 1982 to 2002. *Obesity (Silver Spring)* **14**, 289–294.
8. Papadimitriou A, Kounadi D, Konstantinidou M, Xepapadaki P & Nicolaidou P (2006) Prevalence of obesity in elementary schoolchildren living in Northeast Attica, Greece. *Obesity (Silver Spring)* **14**, 1113–1117.
9. Hiotis D, Tsiftis G, Hatzisimeon M, Krikos X, Maniati XM & Dakou-Voutetaki A (2003) Height and body weight of Greek children aged 0–18 years of age (2001–2002). A comparison with data from a study undertaken in 1978–1979. *Bulletin of the First Padiatric Clinic of the University of Athens Medical School* **50**, issue 2 (in Greek with an English summary).
10. Trichopoulou A (1992) *Composition of Greek Foods and Dishes* (in Greek and English). Athens, Greece: Athens School of Public Health.
11. Trichopoulos D, Tzonou A, Katsouyianni K & Trichopoulou A (1991) Diet and cancer: the role of case–control studies. *Ann Nutr Metab* **35**, 89–92.
12. Trichopoulou A, Toupadaki N, Tzonou A, Katsouyianni K, Manousos O, Kada E & Trichopoulos D (1993) The macronutrient composition of the Greek diet: estimates derived from six case–control studies. *Eur J Clin Nutr* **47**, 549–558.
13. Lagerros YT & Lagiou P (2007) Assessment of physical activity and energy expenditure in epidemiological research of chronic diseases. *Eur J Epidemiol* **22**, 353–362.
14. Wardle J, Brodersen NH, Cole TJ, Jarvis MJ & Boniface DR (2006) Development of adiposity in adolescence: five year longitudinal study of an ethnically and socioeconomically diverse sample of young people in Britain. *BMJ* **332**, 1130–1135.
15. Harding S, Maynard MJ, Cruickshank K & Teyhan A (2007) Overweight, obesity and high blood pressure in an ethnically diverse sample of adolescents in Britain: the Medical Research Council DASH study. *Int J Obes (Lond)* **32**, 82–90.
16. Júlíusson P, Roelants M, Eide G, Hauspie R, Waaler P & Bjerknes R (2007) Overweight and obesity in Norwegian children: secular trends in weight-for-height and skinfolds. *Acta Paediatr* **96**, 1333–1337.
17. Nooyens AC, Koppes LL, Visscher TL, Twisk JW, Kemper HC, Schuit AJ, van Mechelen W & Seidell JC (2007) Adolescent skinfold thickness is a better predictor of high body fatness in adults than is body mass index: the Amsterdam Growth and Health Longitudinal Study. *Am J Clin Nutr* **85**, 1533–1539.
18. van den Hurk K, van Dommelen P, van Buuren S, Verkerk PH & Hirasing RA (2007) Prevalence of overweight and obesity in the Netherlands in 2003, compared to 1980 and 1997. *Arch Dis Child* **92**, 992–995.
19. Pine DS, Goldstein RB, Wolk S & Weissman MM (2001) The association between childhood depression and adulthood body mass index. *Pediatrics* **107**, 1049–1056.
20. Goodman E & Whitaker RC (2002) A prospective study of the role of depression in the development and persistence of adolescent obesity. *Pediatrics* **110**, 497–504.
21. Stunkard AJ, Faith MS & Allison KC (2003) Depression and obesity. *Biol Psychiatry* **54**, 330–337.
22. Willett WC & Stampfer M (1998) Implications of total energy intake for epidemiologic analyses. In *Nutritional Epidemiology*, 2nd ed., pp. 273–301 [WC Willett, editor]. New York: Oxford University Press.
23. Trichopoulou A, Psaltopoulou T, Orfanos P, Hsieh C-C & Trichopoulos D (2007) Low-carbohydrate-high-protein diet and long-term survival in a general population cohort. *Eur J Clin Nutr* **61**, 575–581.
24. Roma-Giannikou E, Adamidis D, Gianniou M, Nikolara R & Matsaniotis N (1997) Nutritional survey in Greek children: nutrient intake. *Eur J Clin Nutr* **51**, 273–285.
25. Hasspidou M, Fotiadou E, Maglara E & Papadopoulou S (2006) Energy intake, diet composition, energy expenditure and body fatness of adolescents in Northern Greece. *Obesity* **14**, 855–862.
26. Astrup A, Astrup A, Buemann B & Raben A (2002) Low-fat diets and energy balance: how does the evidence stand in 2002? *Proc Nutr Soc* **61**, 299–309.
27. Trichopoulou A, Gnardellis C, Benetou V, Lagiou P, Bamia C & Trichopoulos D (2002) Lipid, protein and carbohydrate intake in relation to body mass index. *Eur J Clin Nutr* **56**, 37–43.
28. Field AE, Willett WC, Lissner L & Golditz GA (2007) Dietary fat and weight gain among women in the Nurses Health Study. *Obesity (Silver Spring)* **15**, 967–976.
29. Gunther Al, Buyken AE & Kroke A (2007) Protein intake during the period of complementary feeding and early childhood and the association with body mass index and percentage body fat at 7 y of age. *Am J Clin Nutr* **85**, 1626–1633.
30. Li Y, Zhai F, Yang X, Schouten EG, Hu X, He Y, Luan D & Ma G (2007) Determinants of childhood overweight and obesity in China. *Br J Nutr* **97**, 210–215.

31. Villa I, Yngve A, Poortvliet E, Grjibovski A, Liiv K, Sjöström M & Harro M (2007) Dietary intake among under-, normal- and overweight 9- and 15-year-old Estonian and Swedish Schoolchildren. *Public Health Nutr* **10**, 311–322.

32. Roland-Cachera MF, Deheeger M, Akrout M & Bellisle F (1995) Influence of macronutrients on adiposity development: a follow-up study of nutrition and growth from 10 months to 8 years of age. *Int J Obes Metab Disord* **19**, 573–578.

33. Ma Y, Bertone ER, Stanek EJ 3rd, Reed GW, Hebert JR, Cohen NL, Merriam PA & Ockene IS (2003) Association between eating patterns and obesity in a free-living US adult population. *Am J Epidemiol* **158**, 85–92.

34. Randi G, Pelucchi C, Gallus S *et al.* (2007) Lipid, protein and carbohydrate intake in relation to body mass index: an Italian study. *Public Health Nutr* **10**, 306–310.

35. Toschke AM, Küchenhoff H, Koletzko B & von Kries R (2005) Meal frequency and childhood obesity. *Obes Res* **13**, 1932–1938.

36. Franko DL, Striegel-Moore RH, Thompson D, Affenito SG, Schreiber GB, Daniels SR & Crawford PB (2008) The relationship between meal frequency and body mass index in black and white adolescent girls: more is less. *Int J Obes (Lond)* **32**, 23–29.

37. Mattson MP (2005) The need for controlled studies of the effects of meal frequency on health. *Lancet* **365**, 1978–1980.

38. Cole TJ (2002) A chart to link child centiles of body mass index, weigth and height. *Eur J Clin Nutr* **56**, 1194–1199.