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ORIGINAL ARTICLE

Higher prevalence of obesity in Greek children living in rural areas despite increased levels of physical activity

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Aim: The purpose of the present study was to evaluate whether levels of physical activity (PA) and sedentary behaviours could explain observed differences in the prevalence of childhood obesity in a sample of Greek children.

Methods: Epidemiological study. PA and sedentary behaviours were assessed by a self-administrated PA checklist. Body mass index (BMI) was calculated from measured weight and height. A representative sample of Greek children aged 10–12 years attending fifth and sixth grade ($n = 3195$), living in rural and urban areas, were enrolled. Maturation status was not evaluated due to technical reasons.

Results: Prevalence of obesity was higher among children living in rural areas as compared with urban areas (12.1% vs. 10.7%, $P < 0.01$). Surprisingly, children living in rural areas had higher levels of self-reported PA ($P < 0.001$) and met current PA guidelines to a greater extent than their urban counterparts ($P < 0.05$). Furthermore, boys had higher levels of total, low-to-moderate intensity and vigorous intensity physical activity, as well as sedentary behaviours, than girls (all P-values <0.05). Stratified analysis by BMI category revealed that normal weight boys and girls had higher levels of total PA and vigorous intensity physical activity compared with overweight and obese boys from the same type of setting (all P-values <0.05).

Conclusions: Children living in rural areas have higher levels of PA and more frequently met PA guidelines than their urban counterparts, despite a higher prevalence of obesity.

Key words: children; obesity; physical activity; rural; urban.

What is already known on this topic

1 The prevalence of childhood overweight/obesity in Greece has increased alarmingly in the last decade, while it seems that children living in rural areas are more overweight and obese than their urban counterparts.
2 Only one small study has examined the relationship between physical activity (PA) and obesity levels in Greek children, by rural/urban status. It is thus of great interest to examine, in a large, representative sample of Greek children, the hypothesis that children living in rural areas may have higher obesity rates because of lower levels of PA compared with their urban counterparts.
3 Environmental factors such as rural/urban areas may determine access to sport facilities and opportunities for PA levels and obesity.

What this paper adds

1 Greek children living in rural areas reported higher levels of PA and more frequently met current PA levels than their urban counterparts, despite being more overweight and obese. From the data, it appears that PA may not be directly associated with obesity.
2 Statistical analysis did not reveal significant differences in low-to-moderate PA between obese, overweight and normal weight children from rural areas. From the public health perspective, this is a hopeful message for overweight and obese children.
3 Children living in rural areas spent significantly more time after school in LMPA, (e.g. free games, outdoor play, and outdoor and indoor chores).

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Authors' contributions: KT designed the study, performed the data collection and analysis and wrote the paper. DP and SK participated in the design of the study and critically reviewed the paper. SP participated in the data collection and interpretation. LS was involved in the study design, manuscript writing and in overall supervision of the study.
Conflicts of interest: None declared.

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Introduction

The prevalence of childhood obesity in Greece has increased by approximately 50% in the last decade. At present, over 40% of children are overweight and obese.[1] In a recent study, we found that the area of living played a significant role in the obesity status of Greek children; those living in rural areas are more likely to be obese than their urban counterparts.[2] Surprisingly, the same study reveals that children living in rural areas are nevertheless fitter that urban children.[2] Body weight regulation depends on many factors. Access to energy-rich foods and physical activity (PA) levels constitute the major environmental factors implicated in the regulation of body weight. Differences in PA levels may, therefore, at least in part explain our recent finding that children living in rural areas are more overweight and obese compared with their urban counterparts.[3] Based on the findings that the area of living (e.g. urban vs. rural) may affect access to sports facilities and opportunities for PA,[4] researchers have recognised the environment as a determinant of life-style behaviours.[5] Environmental factors such as public open space and higher 'walkability' scores can influence PA levels and obesity.[6,7] In Greece, rural areas, defined as those with less than 5000 inhabitants and low population density, provide more opportunities for outdoor play and non-compulsory PA.

To the best of our knowledge, only one study in a small, non-representative sample of children has examined the relationship between PA and obesity levels in Greek children.[8] The aim of the present study was to examine the hypothesis that Greek children living in rural areas are more overweight and obese than their urban counterparts because of lower levels of PA.

Methods

Participants' recruitment and procedure

Population data were derived from a national, school-based, follow-up health survey.[2] A total of 3195 children (1602 from the fifth grade and 1593 from the sixth grade) participated in the study. Five hundred eighty-four children (18.2%) were recruited from rural areas and 2611 children (81.8%) were recruited from urban areas. Anthropometric, PA and sedentary behaviour data, and information about age, gender and area of living were collected from children in 70 elementary public and private schools randomly selected from throughout the country. To avoid potential seasonal effects on PA, assessments were performed between September 10 and June 15 (when all schools of primary education in Greece are required to operate). The schools were sampled from 28 prefectures of Greece, representing over 85% of the population. The sampling procedure assured a proportional enrolment of children from urban/rural areas (i.e. flat, mountainous and island locations). Distribution between rural and urban areas was based on the Hellenic National Statistics Service criteria (consensus 2001).[9] Areas with less than 5000 inhabitants and a mean population density of 27 habitants per square kilometer were considered rural.[9]

PA self-report

PA was assessed by the use of the translated version of the Self-Administrated Physical Activity Checklist (SAPAC),[10] with some minor modification for activities most commonly performed by Greek children. In this respect, baseball/softball and American football, sports not common in Greece, were excluded from the questionnaire. Instead, activities such as handball, skiing and martial arts were listed. The SAPAC consisted of 21 activities for which children were asked to report the number of minutes they spent in each activity during the previous day. The day was separated into three time periods: before, during and after school. For every reported activity, children also reported whether it caused them 'to breathe hard or feel tired, none, some or most of the time', providing a subjective estimation of intensity. Additionally, children reported the minutes they spent watching TV/DVD/video and playing games on the TV/computer/mobile phones during the previous day (before and after school). Children completed the questionnaire in the classroom supervised by one of the authors (KDT), who gave a small presentation to improve the accuracy of data reporting. Children were asked to read the completed questionnaire twice and the researcher provided assistance as needed. We have previously reported this questionnaire to have moderate-to-good reliability ($r > 0.85$, $P < 0.001$) and validity ($r = 0.31$ to 0.37, $P < 0.001$).[11]

Study approval

The Ministry of Education of Greece granted approval for the health survey. Parents were notified in writing in advance and had the option to deny participation of their children.

Anthropometric measurements

The same investigator (KDT) measured the height and weight of all children in the study. Weight was measured without shoes using an electronic scale (Body Fat Monitor Scale, TANITA BF-522W, Tokyo, Japan) with a precision of 100 g. Standing height was determined to the nearest 0.5 cm (Leicester Height Measurement, TANITA, Tokyo, Japan) with the child's weight being equally distributed on the two feet, head back and buttock on the vertical land of the height gauge. Body mass index (BMI) cut-off points were used by age and gender category (according to International Obesity Task Force) for underweight, normal weight,[12] overweight and obese,[13] as the most proper for epidemiologic studies.

Data processing and statistical analysis

All PAs in the SAPAC were first coded in metabolic equivalent (MET) values using the original scoring system.[10,14] PAs were classified as low-to-moderate intensity (LMPA) when MET < 5.9, moderate-to-vigorous intensity physical activity (MVPA) when MET ≥ 2.9 and vigorous intensity physical activity (VPA) when MET ≥ 5.9. The minutes of each reported activity were multiplied by the respective MET value to obtain the weighted activity MET score.

Descriptive information on anthropometric measurements, self-reported PA indicators and sedentary behaviours are presented as means ± standard deviation or as percentages. Children were classified as 'active commuters' if they walked or biked to and from school and 'passive commuters' if they were driven to and from school. Additionally, children were stratified by whether or not they met recommended activity levels.

Table 1 Descriptive characteristics and main physical/sedentary activity variables of the participants

	Boys			Girls		
	Rural (*n* = 292)	Urban (*n* = 1343)	All (*n* = 1635)	Rural (*n* = 292)	Urban (*n* = 1268)	All (*n* = 1560)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD) (SD)	Mean (SD)
Age (year)	11.0 (1.0)	11.0 (1.0)	11.0 (1.0)	11.0 (1.0)	11.0 (1.0)	11.0 (1.0)
Weight (kg)	48.7 (11.2)	47.7 (11.6)	47.9 (11.5)	48.6 (10.5)	48.0 (10.7)	48.0 (10.7)
Height (cm)	151.0 (7.9)	149.9 (8.6)	150.1 (8.5)	151.2 (7.9)	150.4 (8.2)	150.6 (8.1)
BMI (kg/m^2)	21.2 (3.5)	21.1 (3.8)	21.1 (3.8)	21.3 (3.5)	21.1 (3.7)	21.1 (3.6)
Overweight (%)	28.3	27.9	28.0	27.9	27.7	27.7
Obese (%)	12.5†	11.1	11.5	11.7†	10.3	10.6
Waist circumference (cm)	73.8 (11.0)	73.5 (11.6)	73.5 (11.2)	72.2 (11.6)	71.8 (11.2)	71.9 (11.1)
Total PA (min/day)	142 (58)*†	124 (54)*	127 (55)	133 (52)†	112 (56)	116 (56)
Low-to-moderate PA (min/day)	83 (42)*†	60 (44)*	64 (42)	103 (48)†	86 (52)	89 (52)
Vigorous PA (min/day)	60 (37)*	64 (44)*	63 (43)	29 (27)	27 (32)	27 (32)
Total MET's score (MET)	746 (325)*†	678 (327)*	690 (328)	640 (264)†	530 (288)	550 (284)
Sedentary behaviours (min/day)	154 (91)*	150 (87)*	151 (86)	139 (83)	140 (84)	139 (83)
Active transportation to school (%)	37.7	48.5†	46.6	36.6	51.1†	48.3
Meeting recommended PA‡ level[3](%)	81.5*†	70.7*	72.5	71.6†	52.9	57.1

Values are mean ± standard deviation (SD) or frequencies (%). *$P < 0.05$ for differences between sexes within the same area (i.e. rural or urban). †$P < 0.001$ between different areas (rural vs. urban) by sex (i.e. boys or girls). ‡Recommended activity level ≥ 60 min of moderate-to-vigorous PA daily. BMI, body mass index; MET, metabolic equivalent; PA, physical activity.

Children who participated in MVPA at least for 60 min/day were considered as meeting the recommendations for PA level.[15] Differences of PA sub-components between genders and areas of living were assessed using independent sample *t*-tests. Comparisons of categorical variables (i.e. gender, areas and BMI categories) were performed using Pearson's χ^2 test. Comparisons between differences of mean values of normally distributed variables between BMI categories were tested using analysis of variance. To evaluate the differences between two specific BMI categories, we applied post hoc analysis using the Bonferroni correction rule to adjust for the inflation of type I error. As the data were normally distributed, the associations between PA sub-components and BMI were tested using linear regression analysis, adjusted for school grade level, kind of school and day of study. Normality of residuals, homoscedacity and serial dependency were graphically assessed through Q–Q plots. All analyses were performed using the SPSS version 18.0 software for Windows (SPSS Inc., Chicago, IL, USA). Statistical significance level from two-sided hypotheses was accepted at the 5% level ($P \leq 0.05$).

Results

Mean values for the participants' descriptive characteristics and for each activity measurement were tabulated by gender and area of living (Table 1). Obesity rates were 1.4% higher in rural than in urban areas for both genders (*P*-values of <0.05) aged 10–12 years (Table 1). Moreover, the prevalence of overweight (including obese) rural children (40.2%) did not differ significantly from that of their urban counterparts (38.5%). Rural children of both sexes reported higher levels of total PA, LMPA and total MET score than their urban counterparts, while a greater proportion of rural versus urban children met current PA guidelines (Table 1). Similarly, when we compared children by area of living, we found that rural children had significantly higher total PA (138 ± 60 min/day) and LMPA (93 ± 54 min/day) compared with urban children (118 ± 56 min/day and 73 ± 54 min/day, respectively), *P*-values of <0.001; for the two groups, VPA was similar (45 ± 44 min/day vs. 45 ± 40 min/day, $P = 0.42$). Furthermore, when we calculated LMPA by time conducted (before, during and after school), we found that rural children had more LMPA after school (73 ± 58 min/day vs. 51 ± 45 min/day, $P < 0.0001$), but the amount of LMPA conducted before and during school did not differ significantly between the two groups. The higher LMPA of rural children was undertaking in the form of free games (e.g. chase, tag, hopscotch), outdoor play (e.g. climbing trees, hide and seek) and outdoor and indoor chores. Gender-specific analysis within the same area of living (rural or urban) revealed that boys had higher levels of total PA, VPA and sedentary behaviours than girls (all *P*-values of <0.05). Stratified data analysis by BMI category between rural and urban children showed that rural boys and girls from the same BMI category reported more total PA and LMPA than their urban counterparts (all *P*-values of <0.05) (Table 2). The total amount of self-reported PA ($P < 0.001$), LMPA ($P < 0.001$), VPA ($P < 0.001$) and active transportation to school ($P < 0.05$) were inversely associated with BMI levels, in both boys and girls living in urban areas. In rural boys, an inverse relationship between BMI and total amount of PA (beta = –0.26, $P < 0.001$) and VPA (beta = –0.28, $P < 0.001$) was observed; for girls, the association between BMI and total PA was less prominent (beta = –0.19, $P = 0.05$) (Table 3).

Table 2 Self-reported physical/sedentary activity variables by BMI group, gender and area of living

Boys	Thinness grades 1–3; (*n* = 143)		Normal weight (*n* = 1721)		Overweight (*n* = 955)		Obese (*n* = 366)	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
	Mean SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Total PA (min/day)	166 (86)	138 (76)	153 (63)*†	138 (60)*	130 (59)†	115 (51)	123 (57)†	97 (44)
Low-to-moderate PA (min/day)	100 (66)†	93 (55)	86 (50)†	74 (49)*	79 (46)†	59 (43)	77 (46)†	55 (40)
Vigorous PA (min/day)	66 (48)	45 (41)	67 (39)*	64 (45)*	52 (41)	56 (39)	46 (39)	42 (33)
Sedentary behaviours (min/day)	54 (54)	148 (120)	109 (66)*	113 (78)*	172 (88)	166 (87)	239 (65)	219 (71)
Active transportation to school (%)	60	58	42	49	35	42	32†	44
Girls								
Total PA (min/day)	107 (14)	125 (56)	142 (62)*†	122 (58)*	124 (52)†	107 (54)	109 (51)†	88 (41)
Low-to-moderate PA (min/day)	76 (16)	99 (57)	105 (66)†	90 (53)‡	95 (47)†	80 (52)	94 (45)†	73 (40)
Vigorous PA (min/day)	31 (28)	26 (33)	37 (32)‡	32 (35)*	29 (27)	27 (31	15 (18)	15 (24)
Sedentary behaviours (min/day)	84 (67)	113 (83)	118 (83)*†	97 (72)*	143 (82)	154 (81)	216 (61)	214 (76)
Active transportation to school (%)	55†	41	43	49	39†	49	40	47

Values are mean ± standard deviation (SD) or frequencies (%). **P* < 0.05 for differences between normal weight and overweight, obese (rural or urban). †*P* < 0.001 for differences between rural and urban areas in the same BMI group. ‡*P* < 0.01 for differences between normal weight and obese (rural or urban). BMI, body mass index; PA, physical activity.

Table 3 Beta coefficients from the linear regression analysis examining the associations between BMI and self-reported PA variables by area of living and gender

	BMI							
	Rural				Urban			
	Boys		Girls		Boys		Girls	
	Beta	*P*	Beta	*P*	Beta	*P*	Beta	*P*
Total PA (min/day)	–0.26	<0.001	–0.19	0.050	–0.30	<0.001	–0.25	<0.001
Low-to-moderate PA (min/day)	–0.06	0.330	–0.07	0.242	–0.14	<0.001	–0.15	<0.001
Vigorous PA (min/day)	–0.28	<0.001	–0.07	0.221	–0.26	<0.001	–0.20	<0.001
Active transportation to school (min/day)	0.05	0.581	0.14	0.139	–0.08	0.06	–0.11	0.012

Adjusted for school grade (fifth or sixth), school (public or private) and day of study (weekday or weekend). BMI, body mass index; PA, physical activity.

Discussion

The present study reveals that Greek children living in rural areas reported higher levels of PA compared with their urban counterparts, despite an increased prevalence of overweight and obesity. This finding is in accord with our previous report[2] that rural children are fitter than urban ones. However, it does not support our hypothesis that rural children are more overweight and obese because they engage in less PA. On the contrary, self-reported PA was significantly higher in rural children.

The data presented here were derived from a follow-up study in a representative sample of 8- to 9-year-old children who participated in an earlier study.[2] The results from this study suggested that rural children had higher levels of obesity but performed better in aerobic fitness, agility and strength than their urban counterparts.[2] The present finding – that rural children have higher levels of PA – explains the better fitness level of these children over urban children. Total PA or MVPA has been implicated as a contributing factor in improved children's aerobic fitness.[16]

The area of living (e.g. rural vs. urban) may determine, at least partly, access to sports facilities and opportunities for PA.[4] Our results confirm the notion that rural environments promote higher levels of PA than urban environments, as we found that children living in rural areas spent significantly more time after school in LMPA, mainly in free games (e.g. chase, tag, hopscotch), outdoor play (e.g. climbing trees, hide and seek) and outdoor and indoor chores. Our main finding is consistent with the findings of most recent studies of the total amount of PA in urban and rural children.[17–21] Self-reported surveys from the USA[17,18] and Canada[21] concluded that urban children were less physically active than rural ones. Furthermore, results of studies from the UK[19] and Switzerland,[20] which have assessed PA via accelometers, agree with the latter observation. In contrast, Huang *et al.*,[22] using the same questionnaire as in the present study, concluded that Taiwanese urban children reported a greater total amount of PA than rural children.

Significantly, post hoc analysis did not reveal significant differences in low-to-moderate PA between obese, overweight and normal weight children from rural areas. From the public health perspective, this is a hopeful message for overweight and obese children. Our target should be to motivate obese children to be more active, creating an encouraging environment for participation in PA and sports at school and other settings without competition and stress.[23] Obese children may be less enthusiastic to participate in vigorous intensity PA because of fear of reduced performance and stigmatisation by their counterparts; they may also be restricted from participating in higher intensity PA because of fear of musculoskeletal injury.[24] Interestingly, the proportion of active transportation to school is significantly lower in rural than in urban children, despite their greater levels of LMPA and total PA. In recent years, the Greek Ministry of Education has merged schools from small villages into larger regional schools to which children must be bussed. This social change may explain the low rates of active transportation to school.

Finally, our data show that, compared with boys, girls reported lower total PA and sub-components of PA (all *P*-values of <0.05). These results are in agreement with those from a recent study of children from 41 countries (including Greece), which concluded that girls reported less PA than boys and fewer girls reach the threshold of ≥60 min/day MVPA recommended for optimal health.[25]

At first sight, the finding that children living in rural areas had higher levels of cardiorespiratory fitness and PA despite their higher prevalence of obesity may appear paradoxical. Apart from PA and fitness, other factors not assessed here (e.g. energy intake, maturity, genetic predisposition to obesity, etc.) seem to play a significant role in the regulation of body weight in children. Differences in dietary habits could influence rural–urban differences in obesity status.[26] In countries like Greece, nutrition transition may have contributed to the increase in obesity prevalence. This transition may have occurred earlier in urban areas. Other possible predisposing factors include lower socioeconomic status,[5] an accepted determinative factor of obesity in established market economies. The level of sexual maturation is well-established to affect childhood obesity and PA levels. Sexual maturation is associated positively with childhood obesity in girls but negatively in boys,[27] so sex-related differences in maturity status may affect PA levels during adolescence.[28,29] Sexual maturation was not assessed in our study and, therefore, we cannot delineate its role in the observed differences between genders in PA or obesity levels.

Study limitations include the fact that we used self-report questionnaires. Widely used due to their convenience and low cost, these questionnaires cannot provide an accurate estimation of the type and duration of PA, and they may not record habitual PA adequately. Moreover, the cross-sectional design of our study cannot establish causal relationships but only provides hypotheses for further investigation.

In conclusion, the results of the present study indicate that the area of residence has a significant effect on self-reported PA and obesity status among 10- to 12-year-old Greek children. As rural children had higher levels of PA and met PA guidelines to a greater extent than their urban counterparts, despite their increased prevalence of obesity, further work should focus on other causes of their obesity levels. A positive finding of the present study is that rural obese children reported a similar degree of participation in LMPA as children in other BMI categories. This is encouraging, especially in view of our recent finding that aerobic fitness in young children has decreased significantly over the past 10 years.[30] We obviously need to further encourage participation in PA and to promote healthy eating to protect the health of our children.

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