

## Prevalence of overweight and abdominal obesity in Greek children 6-12 years old: Results from the National Epidemiological Survey

Tzotzas T, Kapantais E, Tziomalos K, Ioannidis I, Mortoglou A, Bakatselos S, Kaklamanou M, Lanaras L, Kaklamanou D

Hellenic Medical Association for Obesity (HMAO), Athens, Greece

### Abstract

**Objective:** To provide estimates of overweight (OW), obesity (OB) and abdominal obesity (AO) in a sample of children throughout the whole of Greece.

**Material and Methods:** This epidemiological, cross-sectional survey examined 3,140 children aged 6-12 y (1,589 boys and 1,551 girls) who were selected by stratified sampling through household family members of Greek adolescents attending school. Participants reported data on height, weight and waist circumference (WC). BMI and Waist-to-Height ratio (WHtR) were calculated. AO was estimated using WC and WHtR.

**Results:** Overall prevalence of OW including OB was 31.2% in boys and 26.5% in girls, while OB prevalence was 9.4% and 6.4% respectively. The prevalence of AO based on WC (AO-WC), was similar in girls (14.2%) and boys (12.5%) while the prevalence of AO, based on WHtR (AO-WHtR), was higher in boys than in girls (25.6% vs 20.0%,  $p < 0.0001$ ). With increasing age, the prevalence of **OW** and **OB** decreases in both genders, and AO-WHtR only in girls. Rates of OW were significantly more prevalent in Greeks than in immigrants.

**Conclusions:** Overweight and obesity in Greek children is very prevalent, particularly in boys, comparable with that reported for Mediterranean European countries. Abdominal obesity also appears high. Preventive and treatment strategies are urgently needed to combat this national epidemic. Hippokratia 2011; 15 (1): 48-53

**Key words:** overweight, obesity, abdominal fat, prevalence, children, Greece

Corresponding author: Themistoklis Tzotzas, Hellenic Medical Association for Obesity, 46, Kifissias Avenue, 11526 Athens, Greece, Tel.: +30210 6985988, Fax: +30210 6985986, E-mail: info@hmao.gr

Childhood excess weight is a growing problem worldwide, and countries surrounding the Mediterranean sea show particularly high prevalence rates of overall childhood overweight (OW) and obesity (OB)<sup>1,2</sup>. Concerns arise when we look to the fact that, while in the US rates of obesity itself among children showed for the first time no significant changes between the last two national surveys (2003-2004 and 2005-2006)<sup>3</sup>, in many European countries these rates are still increasing, and are expected to reach 10% by 2010<sup>4</sup>.

Greece, a recently modernized Mediterranean country, suffers from a paucity of nationwide data concerning the epidemiology of childhood obesity. Some old reports show that the prevalence of childhood OW is high, while others, more recent, show that OW prevalence in Greece does not differ from that of other southern European countries<sup>5,6</sup>. However, available epidemiological data are scarce and mostly confined to specific geographical areas of the country<sup>6,7</sup>. To our knowledge, the only representative survey on a national scale was conducted in 1990-91 and reported an overall OW prevalence of 17.3% and obesity rates of 3.6% in children and adolescents aged

6-17 years<sup>8</sup>. A recent review on epidemiology and predisposing factors of obesity in Greece showed a tendency for weight increase in children along the last 30 years<sup>9</sup>.

Epidemiological studies have shown that waist circumference (WC) is a highly sensitive and specific measurement of central adiposity in children<sup>10,11</sup>. Some countries have reported epidemiological data on the prevalence of abdominal fat distribution based on WC measurements<sup>11-13</sup>. Besides WC, Waist-to-height ratio (WHtR) has been recently emerged as a valuable index for AO and high cardiovascular risk. This index does not require percentile tables and may be applied to both sexes of all ages<sup>14,15</sup>. A WHtR > 0.5 has been proposed to be able to identify both children and adults with the highest cardiometabolic risk<sup>15</sup>. To the best of our knowledge, there are no reports on the prevalence of abdominal obesity by using the above indexes in Greek children throughout the whole country.

The aim of this large-scale, cross-sectional survey was to provide estimates of overweight, obesity and abdominal fat distribution in a sample of children throughout the whole of Greece.

## Materials and Methods

The present study is part of a nationwide, cross-sectional, epidemiological study designed to estimate prevalence of overweight and abdominal obesity throughout the whole Greek population. Data on obesity in adults aged 20-70 years and adolescents aged 13-19 years were presented previously<sup>16,17</sup>. For the purpose of this large study, anthropometric measurements were taken from adolescents directly at their secondary schools, while the younger children were measured at home with the help of older siblings-who had been measured at school- and parents.

The survey was conducted from February to June 2003 by experienced doctors, all members of the Hellenic Medical Association for Obesity (HMAO), with the approval and collaboration of the Greek Ministry of Education. The selection of the population was performed in collaboration with the Department of Statistics of the Athens University of Economics.

## Sample selection

The methodology of the study was described previously<sup>16,17</sup>. Briefly, the population studied initially consisted of adolescent pupils aged 13-19 years from public schools throughout all parts of Greece (islands included). Secondary schools representing various social classes were included in the sample for selection. The method used for selection was proportionate stratified random sampling (SRS).

From the 3,514 secondary public schools, a sample of 332 (9.45%) was randomly selected. In each school, according to SRS, all the pupils from four out of six classes participated in the study. All adolescents in the survey were measured and completed a questionnaire, at their respective schools. For the purpose of the present study, their younger relatives aged 6 to 12 years were measured, and completed questionnaires at home with the help of their older siblings and parents.

## Procedure

Study approval was obtained from local and state school authorities. After a training period and standardized criteria given by the doctors of HMAO, school physical training instructors were responsible for conducting the survey. After being measured at school, adolescents were invited to help members of their families to take measurements and to complete the detailed questionnaire and, for this purpose, they were appropriately trained by the instructors.

For the present study, all young family members aged 6-12 years living in the house were considered for participation; infants and children under 6 years old were excluded from the survey.

The initial estimated number of siblings was 4,110 children, from which a sample of 3,140 (1,589 boys and 1,551 girls) was measured and entered the study (valid participation rate 76.4%). Due to the fact that the selection of subjects was based on secondary school-aged children, the majority of the participants were in the age group of 13-19 years<sup>17</sup> instead of the age group of 6-12 years. Respondents did not differ from non-respondents in terms of gender and

age in either group. The mean age ( $\pm$ SD) in children studied was 10.0 $\pm$ 1.8 for boys and 10.0 $\pm$ 1.9 years for girls.

## Measurements

With the help of their siblings and parents, all young children were asked to weigh themselves at home or at the nearest pharmacy on electronic or manual scales wearing light clothing and no shoes, and to report weight to the nearest 0.5 kg. To measure height, subjects were asked to be measured using an elastic measuring tape and to report in centimeters to the nearest 0.5 cm. Waist circumference was advised to be measured using a cloth tape midway between the lower rib and the iliac crest.

Body mass index (BMI) was calculated as weight (kg)/height (m<sup>2</sup>). OW and OB prevalences were calculated according to International Obesity Task Force (IOTF) criteria<sup>18</sup>. As there are no international representative curves for WC, as there are for BMI, we used the percentiles and cut-off values for WC determined in Cypriot children aged 6 to 12 years for the evaluation of abdominal fat distribution<sup>19</sup>. All subjects with a WC above the 90<sup>th</sup> percentile for sex and age were defined as abdominally obese (AO-WC), according to the Bogalusa Heart Study<sup>20</sup>. The index WHtR was also calculated and a cut-off point of 0.5 was used to identify children with abdominal obesity at high cardiometabolic risk (AO-WHtR)<sup>15</sup>.

Information on socio-demographic factors associated with the prevalence of OW, OB and AO were collected from the questionnaires, which were anonymous. The variables examined were: age (7 year age groups); residence (urban>20,000 inhabitants, 5,000<semi-urban<20,000 and rural<5,000); ethnicity (Greek born or foreign born).

## Statistical Analysis

Comparisons between BMI, WC and WHtR for each gender and age group studied were made using Student's t-test. Prevalence of overweight, obesity and abdominal obesity were estimated, and proportions were compared using the  $\chi^2$  test. Univariate and multiple regression analyses with logistic regression models were performed in order to evaluate the associations between dependent and independent variables. Adjusted odds ratios (OR) and 95% confidence intervals (CI) were therefore calculated. Results were considered significant at  $p<0.05$ . Statistical analyses were carried out using the SPSS 11.0 software.

## Results

The mean BMI  $\pm$  SD (kg/m<sup>2</sup>) was 18.8 $\pm$ 3.9 kg/m<sup>2</sup> in boys and 18.4 $\pm$ 3.8 kg/m<sup>2</sup> in girls. The mean WC  $\pm$  SD (cm) for boys and girls was 64.5  $\pm$  13.8 cm and 62.9  $\pm$ 12.8 cm, while the mean WHtR was 0.46 $\pm$ 0.09 and 0.45 $\pm$ 0.09, respectively. In both genders, WHtR correlated strongly with Body Weight (boys:  $r=0.33$ ,  $p<0.0001$ , girls:  $r=0.20$ ,  $p<0.0001$ ), BMI (boys:  $r=0.42$ ,  $p<0.0001$ , girls:  $r=0.48$   $p<0.0001$ ) and WC (boys:  $r=0.89$ ,  $p<0.0001$ , girls:  $r=0.84$ ,  $p<0.0001$ ). The Table 1 shows the mean BMI, WC and WHtR in all children by age and gender.

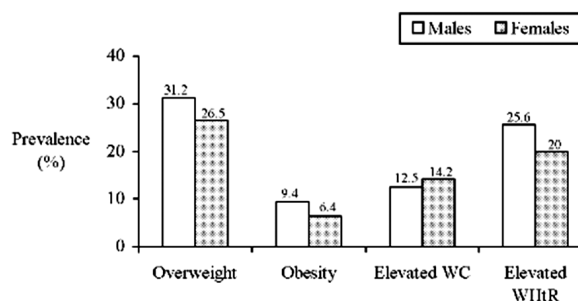
The overall prevalence of OW, including obesity, in boys was 31.2% and in girls, 26.5%, while that of obesity was 9.4% in boys and 6.4% in girls. OW and OB prevalences were higher in boys than in girls ( $p<0.001$ ). The prevalence of AO, based on the index WC, was not statistically different between girls (14.2%) and boys (12.5%) while the prevalence of AO-WHtR was higher in boys than in girls (25.6% vs 20.0%,  $p<0.0001$ ). The figure shows the prevalence of OW, OB and AO by gender in all children (Figure 1).

When associated factors (age, residence and ethnicity) were analyzed simultaneously in a multivariate model, significant independent correlations were found (Table 2). As far as the effect of nationality is concerned, the prevalence of OW increased in Greek boys compared to foreigners (OR: 3.51, CI: 1.36-9.03). Additionally, with increasing age the prevalence of OW and OB decreased in both genders, and AO-WHtR only in girls. On the other hand, we did not observe any difference in weight status and fat distribution related to areas of residence in Greece (Table 2) (results not presented in detail).

## Discussion

This nationwide, cross-sectional epidemiological survey conducted in Greece showed that the overall prevalence of overweight and obesity in children aged 6-12 years was 31.2% in boys and 26.5% in girls, while obesity prevalence was 9.4% and 6.4% respectively. Prevalence of abdominal obesity using the index WC was 12.5% and 14.2% in boys and girls, while using the index WHtR, it was 25.6% and 20.0% respectively.

Only a limited number of studies have examined the prevalence of childhood obesity in Greece, and most of them have been confined to particular geographical areas<sup>6,7</sup>. National measurements were provided by a study



**Figure 1:** Prevalence (%) of overweight (including obesity), obesity, elevated waist circumference (WC) and waist-to-height ratio (WHtR) > 0.5 in children according to gender.

conducted in 1990-91 in children aged 6-17 years, showing an overall prevalence of overweight of 17.3%, similar in both genders<sup>8</sup>. However, in this study, prevalence of OW in younger ages i.e. 6-9 years was found to be higher in girls than in boys, 23 vs 12% respectively. More recent data (2000-2004) from different regions of Greece show some discrepancies, with OW prevalence varying from 30 to 40% in young children<sup>6,7,21,22</sup>.

The present study provides evidence that throughout the country, the prevalence of excess weight is par-

**Table 1:** Mean BMI, WC and WHtR in Greek children by age and gender.

Age groups	BOYS			GIRLS		
	BMI m±SD	WC (cm) m±SD	WHtR m±SD	BMI m±SD	WC (cm) m±SD	WHtR m±SD
6	18.0±5.1	52.0±13.6	0.44±0.12	16.9±3.3	54.0±9.6	0.46±0.08
7	17.7±3.5	57.9±14.9 <sup>†</sup>	0.46±0.11	17.3±3.8	55.9±14.1	0.46±0.11
8	18.4±3.7	58.8±12.6	0.45±0.09	18.5±6.4	57.7±13.1	0.45±0.11
9	18.4±3.5	62.8±11.2	0.46±0.08	18.0±3.2	62.2±12.8	0.46±0.09
10	18.3±3.8	63.1±12.4	0.45±0.08	18.2±3.2	63.0±12.3	0.45±0.08
11	18.9±3.3 <sup>*</sup>	66.2±14.0 <sup>††</sup>	0.45±0.09	18.4±3.0	64.7±12.0	0.44±0.08
12	19.8±3.8 <sup>**</sup>	70.3±12.8 <sup>†††</sup>	0.46±0.08 <sup>###</sup>	19.2±3.3	67.2±11.2	0.44±0.07
<b>Total</b>	<b>18.8±3.9</b>	<b>64.5±13.8</b>	<b>0.46±0.09</b>	<b>18.4±3.8</b>	<b>62.9±12.8</b>	<b>0.45±0.09</b>

BMI: Body Mass Index

WC: Waist Circumference

WHtR: Waist-to-Height ratio

<sup>\*</sup> $p<0.05$ , <sup>\*\*</sup> $p<0.01$  for comparison of BMI between boys and girls

<sup>†</sup> $p<0.05$ , <sup>††</sup> $p<0.01$ , <sup>†††</sup> $p<0.001$  for comparison of WC between boys and girls

<sup>###</sup>  $p<0.001$  for comparison of WHtR between boys and girls

**Table 2:** Predictors of overweight, obesity and abdominal obesity in both genders in multivariate analysis.

Predictor	BOYS						GIRLS											
	Overweight		Obesity		Abdominal obesity		Overweight		Obesity		Abdominal obesity							
	OR (95%CI)	P	OR (95%CI)	P	OR (95%CI)	P	OR (95%CI)	P	OR (95%CI)	P	OR (95%CI)	P						
Age		< 0.001		< 0.001		NS		< 0.001		< 0.001		< 0.001						
6 years (reference)	1.0		1.0		1.0		1.0		1.0		1.0							
7 years	1.04	0.56-1.92	NS	0.76	0.38-1.52	NS	1.25	0.64-2.43	NS	0.81	0.45-1.45	NS	0.85	0.41-1.79	NS	1.15	0.62-2.12	NS
8 years	0.98	0.55-1.75	NS	0.56	0.28-1.11	NS	0.95	0.49-1.81	NS	0.82	0.48-1.41	NS	0.51	0.24-1.06	NS	0.71	0.39-1.29	NS
9 years	0.78	0.44-1.36	NS	0.31	0.15-0.63	0.001	0.86	0.46-1.61	NS	0.69	0.40-1.19	NS	0.41	0.19-0.89	0.024	0.83	0.46-1.49	NS
10 years	0.43	0.25-0.75	0.003	0.14	0.07-0.29	< 0.001	0.70	0.39-1.29	NS	0.45	0.26-0.76	0.003	0.30	0.14-0.64	0.002	0.54	0.31-0.96	0.036
11 years	0.48	0.28-0.83	0.009	0.13	0.06-0.27	< 0.001	0.82	0.45-1.49	NS	0.29	0.17-0.49	< 0.001	0.09	0.04-0.24	< 0.001	0.46	0.26-0.79	0.006
12 years	0.63	0.37-1.05	NS	0.19	0.09-0.36	< 0.001	1.04	0.59-1.83	NS	0.37	0.23-0.61	< 0.001	0.07	0.03-0.17	< 0.001	0.37	0.21-0.63	< 0.001
Greek ethnicity (vs. foreign)	3.51	1.36-9.03	0.009	2.22	0.52-9.53	NS	1.70	0.75-3.90	NS	0.77	0.35-1.72	NS	0.79	0.18-3.56	NS	1.20	0.45-3.21	NS
Residence			NS			NS			NS			NS			NS			NS
Rural (reference)	1.0			1.0			1.0			1.0			1.0			1.0		
Semi-urban	0.84	0.61-1.16	NS	0.88	0.52-1.49	NS	0.90	0.64-1.27	NS	0.92	0.66-1.28	NS	0.77	0.41-1.43	NS	0.74	0.51-1.07	NS
Urban	0.95	0.73-1.23	NS	1.05	0.69-1.59	NS	1.25	0.95-1.65	NS	0.84	0.63-1.12	NS	0.84	0.51-1.41	NS	0.79	0.58-1.07	NS

Abdominal obesity defined as WHtR>0.5

OR: Odds Ratio, NS: Not Significant

ticularly high, more in boys than in girls, exceeding 30%. Our results are consistent with data previously reported in 2000 from a region of Northern Greece<sup>6</sup>. Compared with the previous national survey conducted 12 years ago<sup>8</sup>, which was also based on IOTF cut-off values, we have observed a sharp increase in overweight in boys by more than 150%, while overweight rates in girls have remained relatively stable at about 23-26%. Similar trends in overweight prevalence related to gender were observed by Magkos et al<sup>7</sup>, who found that the OW% in Cretan children had more than doubled from 1982 to 2002 among boys aged 9 and 12 years. Papadimitriou et al<sup>22</sup> also demonstrated an increase in the prevalence of OW from 1994 to 2004 averaging 4% in both genders. A very recent comprehensive review reported the prevalence of OW and OB at both regional and national level in Greece from the Second World War till today and concluded that there is an ongoing tendency for body weight increase during the last 30 years<sup>9</sup>.

This epidemic of childhood obesity in Greece is comparable with that observed in other Mediterranean Euro-

pean countries, such as Spain<sup>23</sup>, Italy<sup>24</sup>, Portugal<sup>25</sup> and in the United Kingdom<sup>26</sup>, and is approaching rates reported from the USA, at least in some age categories<sup>27</sup>.

The reasons for the obesity epidemic in the Greek pediatric population are not clear. The 'nutrition transition phenomenon' which consists of a series of changes in diet, physical activity and health as poor countries become more prosperous, was particularly intense in Greece. In fact, the country underwent rapid socioeconomic development during the late 1970's, joined the European Union and experienced a 'western type' modernization. This delayed yet sharp economic evolution resulted in a rapid change from the traditional Mediterranean diet to the western-type diet<sup>28,29</sup>. Actually, the few studies that have estimated current nutrient intake levels and food group consumption patterns in Greek children indicate overintake of total and saturate fat, and underintake of carbohydrates, particularly in overweight children<sup>30,31</sup>. These dietary changes probably account, at least in part, for the childhood obesity epidemic in Greece.

Lack of physical activity or increasing sedentary be-

havior may also contribute to the problem of excess body weight in Greece. Physical activity patterns are often, but not always, found to be inversely related to BMI and obesity prevalence<sup>21,32</sup>. More consistent are the results of recent studies showing that a sedentary lifestyle due to excess television viewing in particular, highly contributes to this epidemic of obesity<sup>32,33</sup>.

When looking at factors such as physical activity and diet, we must also take into account larger historical or cultural trends in Greece<sup>9</sup>. The nuclear-type family unit is a fundamental aspect of Greek life and child care is an extended family effort. A study looking at a sample of Greek children aged 8-12 y showed a positive relationship between OB rates and children living in homes where the grandmother did the cooking<sup>34</sup>. It has been suggested that childhood OB, may partly be accounted for by the over-protective attitude and forced feeding by Greek parents<sup>5</sup>.

It has to be underlined that, in our study, childhood overweight affects the Greek male population significantly more than the foreign male population, the latter being represented by immigrants from neighbouring developing countries (e.g. some Balkan States and ex-Soviet Union countries). This is in contrast with most studies showing that a lower prevalence of obesity is seen at higher income and high levels of socioeconomic status in children of more modernized societies<sup>35,36</sup>. Our findings could probably be explained by the fact that immigrants in Greece are first generation immigrants and, therefore, they are less affected by the "western type" lifestyle. This aspect was also found in adolescents of this survey<sup>17</sup> and has been reported by other investigators<sup>22,34</sup>.

Interestingly, we found that the indexes WC and WHtR identified far more children of both genders as obese compared to BMI. We have previously reported similar findings in our survey for adolescents and adults by using BMI and WC as indicators for obesity and abdominal obesity respectively<sup>16,17</sup>. It is probable that in Greece, as in other countries, the prevalence of obesity prone to complications has been underestimated, as BMI is a poor proxy for central fatness<sup>37</sup>. Additionally, recent data from the UK and Australia showed that abdominal obesity increased at a higher rate than overall obesity over the past 10-20 years in children<sup>11,38,39</sup>. The increase in AO is probably a cause of concern also in Greece since, in one Greek study, WC measurements that were performed in children 6-12 years from 2000 to 2002, showed an important increase from  $60.8 \pm 7.1$  to  $65.0 \pm 7.7$  cm<sup>40</sup>. Noticeably, the mean WC in the 2002 cohort was comparable to that found in children of the present survey.

Some discrepancies between the two indices for evaluating AO have been mentioned. It has been reported that WHtR cut-off value of 0,5 in children may generate a higher prevalence of AO than that using >90<sup>th</sup> percentile for WC by gender and age, and this is more pronounced in very young children aged 2-5 years<sup>11,12</sup>. In our study, using the same cut-off points for both indices as the American study, we have also identified higher prevalence of AO using WHtR than WC in both genders. Both indexes

identified equal prevalence for boys and girls, in most ages -with the exception of ages 11 and 12 years-, where the index WHtR was significantly higher in boys than in girls. The above difference probably reflects the extra fat accumulation in boys due to initiation of pubertal changes. In the British study, boys had lower WHtR at all ages (5-16y), however these differences were most prominent after the age of 9 years.

Comparisons of our WC and WHtR data with existing international data are of particular interest. Using WC, comparisons with the USA study (NHANES 2003-2004), which was concomitant to our study, showed that the percentage of children with a high WC was lower in our Greek children than in US children of similar age; this difference was more evidence in girls<sup>12</sup>. On the other hand, mean WC values observed in our children were lower higher than their age-matched peers from Holland (1996-97)<sup>3</sup>, Sweden (1996)<sup>41</sup>, Australia (1997-2002)<sup>42</sup> and United Kingdom (1988)<sup>11</sup>.

As for the index WHtR, again US children (NHANES 2003-2004) of the same age had a greater proportion of WHtR>0,5 than our counterparts and this difference was more prominent in girls<sup>12</sup>. However, percentages of WHtR>0,5 were higher in children of our study than in children of same age of Sweden<sup>41</sup> and the United Kingdom<sup>38</sup>.

The major limitation of our study was the use of indirect measurements for the evaluation of BMI status in children and that the sample of selected children was not representative for the whole of Greece.

In conclusion, we observed high rates of overweight and obesity in Greek children, particularly in boys, comparable with that reported for most Mediterranean European countries. Abdominal obesity is also high, higher than that recently reported from other European countries. Preventive and treatment strategies are urgently needed to combat this obesity epidemic in Greece.

#### Disclosure

The authors declared no conflict of interest.

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