

**Prevalence of overweight and obesity in preschool children in Thessaloniki, Greece**

**Abbreviated title:** Obesity prevalence in Greek preschoolers

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**Key words:** Obesity, BMI, international reference, greek preschoolers, anthropometry

**Conflict of interest statement**

There is no conflict of interest.

## **Abstract**

**Objective:** Data on obesity in preschoolers are scarce in Greece, a country particularly affected by the obesity epidemic. The present study aimed to assess overweight and obesity prevalence of preschoolers in Thessaloniki, Greece by using three different standards for defining childhood overweight and obesity.

**Design:** One thousand two hundred and fifty preschool children (657 boys and 593 girls) aged 2.0-6.0 years old from all public municipality kindergartens of Thessaloniki-Greece participated in this cross-sectional survey conducted from 2009 to 2010. Body weight and height were measured and detailed anthropometry measurement was undertaken. BMI was classified to weight categories based on CDC (US Centers for Disease Control and Prevention), IOTF (the International Obesity Task Force) and WHO (the World Health Organization) references.

**Results:** Rates of excess body weight varied significantly according to different international criteria: IOTF, overweight (including obesity) 21.2%, obesity 5.8%; CDC, overweight (including obesity) 30.5% ,obesity 13.5%; and WHO, overweight (including obesity) 32.6%, obesity 5%. Boys and older children were particularly affected.

**Conclusions:** Overweight prevalence is high in Greek preschoolers and varies significantly according to the different criteria used, from 21.2% (IOTF) to 32.6% (CDC reference).

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## Introduction

Over the last decades, the prevalence of childhood obesity has increased dramatically worldwide and in some countries like Greece has resulted in a public health issue.<sup>1,2</sup> Obesity in preschool age is poorly studied compared to school age and adolescence, despite the fact that excess body mass index (BMI) in preschool age has been identified as a risk factor for obesity in early adulthood.<sup>3</sup> Existing data support the view that childhood obesity occurs at younger ages primarily when children enter kindergartens.<sup>4</sup> To the best of our knowledge, only one Greek study, the Genesis study, investigated excess body weight in preschoolers and reported high prevalence of overweight.<sup>5</sup> Cattaneo et al.<sup>6</sup> reviewed existing data in the European Union and reported that Greek preschoolers demonstrated high overweight and obesity rates, which is in agreement with overweight-obesity trends reported in other Mediterranean European countries and England.

Overweight in childhood can be determined with accuracy using BMI but different criteria for BMI category classification have been developed. The three references mostly used are: a) the 2000 Centers for the Disease Control and Prevention (CDC) charts at the 85<sup>th</sup> and 95<sup>th</sup> percentiles, classifying children and adolescents as overweight ( $\geq 85^{\text{th}}$  to  $< 95^{\text{th}}$  percentile) and obese ( $\geq 95^{\text{th}}$  percentile), mostly used in USA<sup>7</sup>; b) the International Obesity Task Force (IOTF) which provided gender-specific values from 2 to 18 years of age, corresponding to BMI cut off limits of adulthood that is 25 kg/m<sup>2</sup> for overweight and 30 kg/m<sup>2</sup> for obesity;<sup>8</sup> and c) the 2007 World Health Organization (WHO) growth curves using BMI z scores +1 and +2 standard deviations (SD), for defining respectively overweight and obesity.<sup>9</sup> The IOTF criteria are now mostly used universally for quantifying and comparing the prevalence of overweight and obesity between different populations.

Besides BMI, Waist-to-height ratio (WHtR) has been recently emerged as an important index for defining abdominal obesity (AO) and high cardiometabolic risk and WHtR exceeding 0.5 has been proposed to be pathological in both children and adults.<sup>10</sup>

Anthropometry is an important tool for individual assessment as well as for planning at population level and importantly anthropometric data for children reflect general health, nutritional status and physical development.<sup>11</sup> There is now a consensus that indicators based on weight and height measurements should be used for early identification of weight gain in children.<sup>12</sup> Anthropometric reference for international

use was released from World Health Organization (WHO)<sup>13</sup> and data for US population based on NHANES survey 1999-2002<sup>14</sup> were reported and used for estimating obesity trends in young children.

The primary objective of the present cross-sectional study was to assess overweight and obesity status in a sample of preschoolers 2-6 years old, in Thessaloniki, the second largest city in Greece after Athens. Secondly, comparison between prevalence estimates of the overweight-obesity using three sets of growth references i.e. IOTF, WHO and CDC was undertaken.

## **Methods**

### **Sample**

The study was carried out in all (nineteen) public nurseries of Thessaloniki Municipality, in Northern Greece, during the school year from September 2009 to June 2010. Undersigned approval was obtained from the Greek Ministry of Health, and the Prefecture medical officer. All parents/caregivers of participants signed a written informed consent form prior to the implementation of the study procedures.

The Alexander Technological Educational Institute's Ethics committee approved the study design and implementation. The study was conducted according to the Helsinki Declaration. The sample analyzed consisted of 1006 preschool children 529 boys and 477 girls aged 2.0-6.0 years old (mean age  $3.94 \pm 0.87$  years). Initial number of all children in the kindergartens was 1250 children (657 boys, 593 girls). Participation rate, including valid provided data, was 80.5% of the initial sample.

### **Anthropometry**

Anthropometric measurements were taken according to WHO Multicentre Growth Reference Study Group.<sup>15</sup> Body weight measurement was performed using an electronic scale (Seca 813, Germany) to the nearest 100 g. Height was measured to the nearest 0.5 cm, using a portable stadiometer (Charder, Taiwan). For mid upper arm (MUAC) (measured at the mid-point of olecranon and acromium) and waist circumference (WC) (measured at midway between the iliac crest and the lowest border of the rib cage), a wide flat plastic tape strip was used.<sup>12</sup> Lange calipers (Beta Technology Inc, Santa Cruz) were used for triceps (Ts) skinfold, measured at the midpoint between the acromion and the olecranon, subscapular (Ss), measured at 1 cm below the inferior angle of the scapula, and supriliac (SIs) skinfold measured 1 cm over the iliac crest at the midaxillary line. Body fat percentage (BF%) was calculated using Slaughter equations.<sup>16</sup> All measurements were taken three times and an average value was recorded. Circumferences and skinfolds were measured at the left side of the body. BMI and Waist to Height Ratio (WHtR) were also calculated.  $WHtR > 0.5$  was considered elevated and identified children as abdominally obese<sup>10</sup>. Overweight and obesity status was appreciated using IOTF,<sup>8</sup> WHO<sup>9</sup> and CDC criteria.<sup>7</sup> Epi Info software v 3.5.1, developed by CDC was used for the calculation of all percentiles. The Anthro plus software v 3.0.1, delivered by WHO, was used for the calculation of z scores according to WHO growth charts.

**Statistical analysis**

Statistical analysis was performed using SPSS v.17 software (SPSS Inc, Chicago Ill). Continuous and categorical variables are presented as mean $\pm$ SD and as percentages, respectively. Differences in categorical variables between groups were evaluated with the chi-square test. Differences in continuous variables between groups were evaluated with one-way analysis of variance and post-hoc, pairwise comparisons were performed with the Holm-Sidak test. Statistical significance was set at  $p < 0.05$ .

## Results

Anthropometric characteristics of preschool children of both sexes, classified in age categories are shown in table 1. Overall, BMI was higher -at the limit of significance ( $p=0.052$ )- in boys than in girls. WC and WHtR showed no statistical difference while BF% was higher in girls than in boys. As presented in table 2, an increase in WC and a decrease in WHtR by age categories was observed in both genders ( $p$  for trend  $<0.001$ ) while an increase in BF% was shown only in girls ( $p$  for trend  $=0.039$ ).

Table 3 shows prevalence of overweight and obesity according to IOTF, WHO and CDC references. Overall overweight prevalence according to IOTF, WHO and CDC was 21.2%, 32.6% and 30.5% respectively. Concerning overweight, IOTF rates were 1.54 and 1.44 times significantly lower than WHO ( $p<0.001$ ) and CDC ( $p<0.001$ ) respectively. CDC overweight percentage was 1.07 times significantly lower compared to WHO ( $p<0.001$ ). Obesity rates derived from IOTF, WHO and CDC references were 5.8%, 5% and 13.5%, respectively. CDC demonstrated 2.33 and 2.70 times significantly higher obesity prevalence compared to IOTF ( $p<0.001$ ) and WHO ( $p<0.001$ ) respectively.

Significantly higher prevalence of overweight was demonstrated for boys compared to girls using IOTF and CDC ( $p<0.001$ ). Obesity rates were significantly higher in boys compared to girls according to all international criteria ( $p<0.001$ ).

Finally, based on the WHtR index, 239 boys (45.2%) and 207 of the girls (43.4%) were found abdominally obese (WHtR $>0.5$ ).

## Discussion

The present study conducted in Thessaloniki, the second largest city in Greece, showed that the prevalence of overweight (including obesity) was high in preschool children and it varied by different international criteria i.e. 21.2% according to IOTF, 32.6% as defined by WHO reference and 30.5% by CDC. Obesity rates were found to be 5.8%, 5% and 13.5% for IOTF, WHO and CDC respectively.

In Greece, obesity is a major health issue; affecting all age groups in both genders.<sup>2</sup> This epidemic phenomenon seems to affect notably preschool children. Only one study though, the GENESIS study, has previously investigated obesity prevalence in preschoolers in Greece.<sup>5</sup> This study which was conducted in 2003-2004 and included children aged 1-5 years old from the whole country, showed high prevalence of overweight, varying from 21.3% (IOTF criteria) to 31.9% (CDC criteria). Interestingly, these rates are fairly comparable to those found in our regional study conducted after six years and illustrate the severity of the problem even from the very young ages. At least, it appears that it has been no substantial increase in excess body weight in preschoolers from 2003-04 to 2009-10, although no direct comparisons can be done between the two studies. Concerning age, WC and WHtR but not BMI were found to increase by different age-groups in both genders, while estimation of body fat increased significantly by age only in girls. This finding indicates that adiposity rebound occurs at earlier age in girls than in boys<sup>17</sup>. Noticeably, some other gender differences emerged from our regional study. Significantly much more boys than girls were classified in the obese category and this applied for most age-groups. Overweight prevalence was also higher for boys using IOTF and CDC criteria, while using WHO cut-offs both genders were equally affected. In most European countries, overweight rates in girls tend to be higher than those in boys using the IOTF cut-offs, but not using the WHO standards.<sup>6</sup> Similarly, in the Genesis study, excess body weight was more pronounced in girls than in boys.<sup>5</sup> However, the last NHANES which provided measured representative data among US children and adolescents in 2009-2010 using the CDC criteria showed, in age-group 2-5 y, higher rates of overweight and obesity in boys than in girls.<sup>18</sup> Based on these data, we believe that no definite conclusions can be drawn in terms of gender differences.

The review of existing data by Cattaneo et al, in 2010, synthesized all available information on prevalence of overweight and obesity in preschool children in the European Union. The authors concluded that countries in the Mediterranean region

and the British islands had higher rates than those in middle, northern and eastern Europe. In fact, the rates of overweight in the present study are fairly similar to those of other Mediterranean countries reported in the above mentioned review.<sup>6</sup> It would be of interest to compare our results with those of other urban European cities as well. For example in the city of Leeds, UK, using British reference data set the proportions of preschool children who were overweight were 18% while that of obesity 6.6% which indicates similar trends with our study.<sup>19</sup>

When comparing our results with more recent studies using the same IOTF criteria, we found similar rates of overweight (including obesity) with Italy - 21.2% in both countries- but significantly higher from Poland (17.2%) and Denmark (14.6%).<sup>20</sup> Interestingly, the latest NHANES in USA, which was conducted during the same timeframe with our study showed, in age-group 2-5 y, prevalence of overweight (including obesity) at 26.7% and obesity at 12.1% in both sexes using CDC criteria.<sup>18</sup> These rates are lower than those reported in our study, which are 30.5 % for the overweight (obesity) and 13.5% for obesity.

In preschoolers several growth charts were developed internationally because of important ethnic differences and adiposity changes.<sup>9</sup> The IOTF reference is based on children from cross-sectional surveys designed to be representative of the whole population, the WHO standard is based on sample of healthy children selected to represent optimal growth and the CDC shows normal growth in children from US national survey data.<sup>9,21</sup> These three international methods mostly used to define overweight and obesity based on BMI cut-off points, generate marked different results. In accordance with previous studies<sup>9,21</sup>, our current results showed that in the overweight category the IOTF cut-off points produced the lowest estimates, the WHO the highest while the CDC cut-points tended to be lower than those of the WHO particularly in boys. The reason for these discrepancies is that the WHO curves at +1SD is a much lower cut-off point compared to other two criteria and, therefore increases the prevalence of those classified as overweight.<sup>9</sup> Two recent studies that were conducted in Japan and in Canada and used all three criteria reported comparable outcomes.<sup>22, 23</sup> It should be also emphasized that differences between IOTF and WHO estimates tend to be more pronounced in boys than in girls, a finding that was also reported in the Canadian study.<sup>21,23</sup> In the obese category of the present study, CDC estimates were significantly higher compared to IOTF and WHO respectively whilst WHO and IOTF criteria showed similar rates. The higher obesity

estimates found with CDC criteria could result from the fact that cut-off limits by WHO (2SD above the mean) are higher than that of CDC (95th percentile) for defining obesity.<sup>9</sup> Concerning IOTF values, sensitivity and specificity for defining obesity is lower than for defining overweight.<sup>21</sup>

Inadequate breastfeeding<sup>2</sup> and heredity from the parents<sup>5</sup> are possible causes for increased body weight in preschoolers in Greece. Other lifestyle factors like overweight at early age, maternal educational level, race/ethnicity and hours of television viewing could also play a role as already indicated in similar studies<sup>24-26</sup>.

The present study was conducted at the biennium 2009-2010, just at the beginning of the economic crisis. Thus overweight and obesity in the preschoolers may have worsen due to economic recession of households that could lead to increased purchase of low cost processed, high-fat food and consequently to poor nutrition and health<sup>27</sup>. Previous studies have suggested that economic recession resulted to reduced access to a nutritious diet and impaired nutritional status and health.<sup>28, 29</sup> Whether the current financial crisis in Greece has had a deteriorating effect in the obesity prevalence merits further investigation in future studies.

Limitations of the study are the cross-sectional design and the lack of data on associated factors that would enable us to draw conclusions on possible causes and effects. Furthermore, this is a study in a big urban city of Greece and conclusions on the results cannot be generalized for the whole country. Finally we used skinfolds measurement for evaluation of body fat % which seems to be a less accurate method than others (e.g. bioelectrical impedance analysis) in this particular pediatric population.<sup>30</sup> In addition, estimating the total body fatness using Slaughter equations has not been validated for preschool children but only for older children.<sup>31</sup>

For these reasons we did not focus our discussion on these anthropometric parameters but just provided relevant data. On the other hand, important strengths are the inclusion of all municipal kindergartens of the city in the sample and the high participation rate.

## **Conclusions**

Overweight (including obesity) prevalence in Northern Greece preschoolers was found elevated and varied significantly according to different criteria used, i.e. from 21.2% (IOTF) to 32.6% (CDC). Overweight and obesity was found to be predominantly dominant among boys and older children. Concerning the references used, overweight rates were similarly defined by WHO and CDC criteria, while CDC seemed to overestimate obesity. The variations on overweight and obesity estimation using IOTF, WHO and CDC criteria indicate the need of a detailed validation of those tools, especially when preschool children are being measured.

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**Table 1:** Comparison of anthropometric parameters between genders in each age category.

Age groups	Body mass index (kg/m <sup>2</sup> )			Waist circumference (cm)			Waist-to-height ratio			Body fat %		
	Boys	Girls	p	Boys	Girls	p	Boys	Girls	p	Boys	Girls	p
<b>2-3 years (n=73)</b>	16.32±1.58	16.45±1.90	0.756	49.73±3.66	48.46±3.05	0.123	0.55±0.04	0.53±0.04	0.237	14.28±3.49	15.43±3.13	0.152
<b>3-4 years (n=292)</b>	16.50±1.68	16.03±1.93	0.029	50.75±3.66	50.09±3.12	0.104	0.51±0.04	0.52±0.03	0.258	14.32±3.75	14.81±3.04	0.226
<b>4-5 years (n=404)</b>	16.63±1.78	16.35±1.69	0.095	52.71±4.10	52.10±3.95	0.130	0.50±0.03	0.50±0.03	0.364	14.23±4.25	15.83±4.12	<0.001
<b>5-6 years (n=246)</b>	16.38±2.05	16.42±2.25	0.904	53.13±4.41	53.39±5.04	0.672	0.48±0.04	0.49±0.04	0.375	14.59±4.58	16.13±4.48	0.010
<b>Overall (n=1006)</b>	16.51±1.80	16.28±1.91	0.052	51.98±4.18	51.61±4.23	0.163	0.50±0.04	0.50±0.04	0.785	14.35±4.13	15.59±3.91	<0.001

p<0.05 for statistical significant difference

**Table 2.** Differences in anthropometric parameters between age groups in boys and girls.

	<b>p for trend for the comparison between age groups</b>		<b>Pairwise comparisons between age groups</b>					
			<b>2-3 vs. 3-4 years</b>		<b>3-4 vs. 4-5 years</b>		<b>4-5 vs. 5-6 years</b>	
	<b>Boys</b>	<b>Girls</b>	<b>Boys</b>	<b>Girls</b>	<b>Boys</b>	<b>Girls</b>	<b>Boys</b>	<b>Girls</b>
<b>Body mass index</b>	0.567	0.352	0.994	0.861	0.980	0.609	0.781	1.000
<b>Waist circumference</b>	<0.001	<0.001	0.600	0.232	<0.001	<0.001	0.934	0.038
<b>Waist-to-height ratio</b>	<0.001	<0.001	<0.001	0.137	0.018	<0.001	0.001	0.247
<b>Body fat %</b>	0.893	0.039	1.000	0.964	1.000	0.109	0.971	0.985

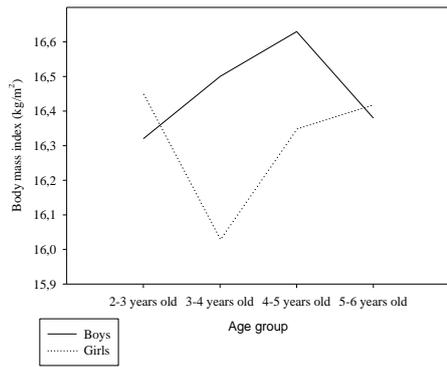
p<0.05 for statistical significant difference

**Table 3:** Prevalence of overweight (including obesity) and obesity according to the US Centers for Disease Control and Prevention (CDC), International Obesity Task Force (IOTF) and World Health Organization (WHO) criteria in boys and girls and in the different age groups.

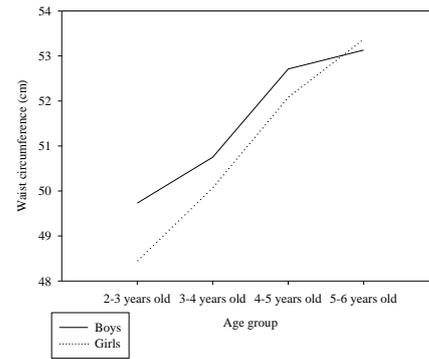
	Prevalence of overweight (including						Prevalence of obesity (%)					
	IOTF criteria		WHO		CDC criteria		IOTF		WHO criteria		CDC criteria	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
<b>2-3 years old (n=43)</b>	20.9	20.0	25.6*	36.7	18.6	16.7	0.0	3.3	4.7	3.3	4.7	3.3
<b>3-4 years old (n=158)</b>	17.1*	11.9	22.8*	30.6	25.9*	21.6	3.8*	1.5	2.5*	0.7	12.0**	6.7
<b>4-5 years old (n=203)</b>	23.6	22.9	44.3*	36.3	38.4	35.3	7.4	6.0	14.3**	2.5	20.7**	13.9
<b>5-6 years old (n=125)</b>	25.6	25.9	27.2	28.6	31.2	32.1	9.6	8.9	2.4	4.5	17.6**	11.6
<b>Total (n=529)</b>	21.9*	20.3	32.3	32.9	31.4*	29.6	6.2*	5.2	7.2**	2.5	16.1**	10.7
<b>Both sexes (n=1006)</b>	21.2		32.6		30.5		5.8		5.0		13.5	

\*p<0.05 and \*\*p<0.01 for comparison of prevalence of overweight and obesity between boys and girls of same age-groups

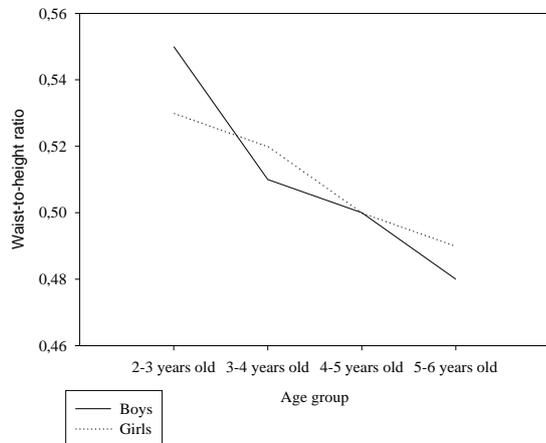
**Figure 1.** Mean body mass index according to gender and age category.



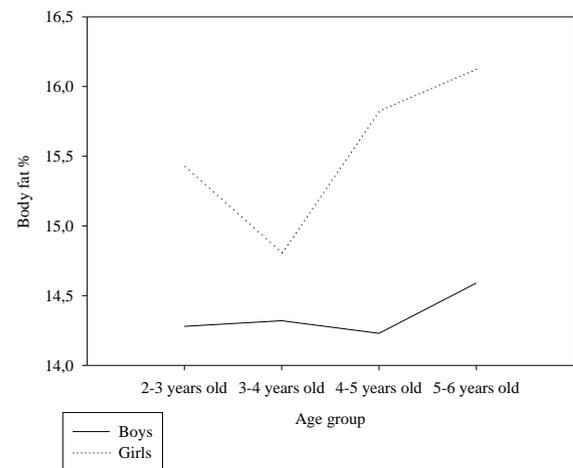
**Figure 2.** Mean waist circumference according to gender and age category.



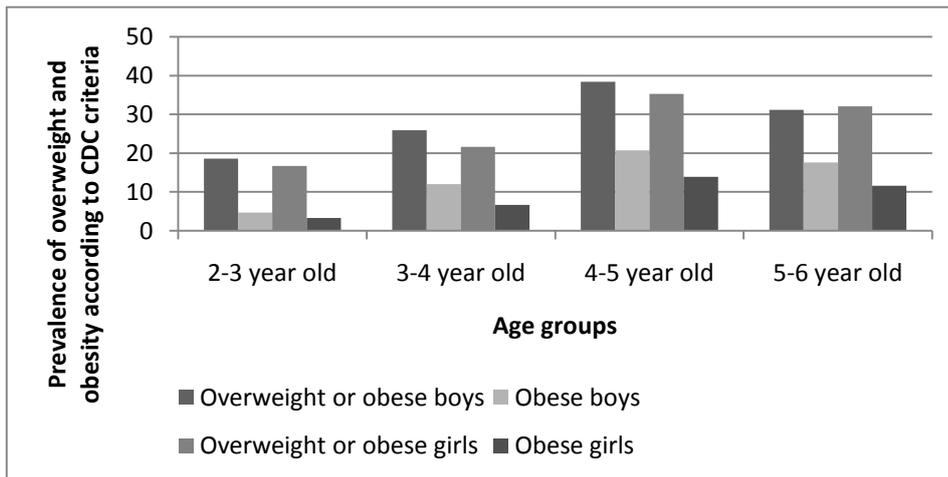
**Figure 3.** Mean waist-to-height ratio according to gender and age category.



**Figure 4.** Mean body fat % according to gender and age category.



**Figure 5.** Prevalence of overweight according to gender and age group based on the Centers for the Disease Control and Prevention (CDC) criteria.



**Figure 6.** Prevalence of overweight and obesity according to gender and age group based on the International Obesity Task Force (IOTF) criteria.



**Figure 7.** Prevalence of overweight and obesity according to gender and age group based on the World Health Organization (WHO) criteria.



