



## Original research

## Geographical distribution of simple and abdominal obesity among 17-year-old adolescents in Greece



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## ABSTRACT

**Aim:** The study aimed to assess the prevalence of simple and abdominal obesity, among 17-year-olds, in each geographical district of Greece.

**Methods:** A nationally representative sample of 5759 adolescents was recruited from secondary schools. Weight, stature and waist circumference were measured. Weight status was defined according to the International Obesity Task Force criteria and abdominal obesity with the International Diabetes Federation criteria.

**Results:** The majority of the adolescents were classified as normoweight (70.9%), 3.9% were underweight, 19.3% were overweight and 5.3% obese, while 8.9% were centrally obese. Underweight ranged from 2.6% in Crete to 8.9% in central Greece. Obesity ranged from 4.8% in Epirus to 8.8% in the Aegean islands. The prevalence of overweight spanned from 15.8% (Ionian Islands and Crete) to 23.9% in the Aegean Sea. The highest prevalence of overweight plus obesity was recorded in the Aegean islands, while central obesity was more prevalent in Thessaly.

**Conclusion:** The study indicates a variation in the prevalence of overweight and obesity throughout Greece and identifies obesogenic hotspots. These results could be of use for the development of regional school-based intervention protocols.

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## 1. Introduction

Adolescence consists of a period of developmental transition, facilitating the physiological progression from childhood to adulthood. Due to their young age, adolescents are generally considered healthy, and for years, this mistaken belief hampered research on adolescent health (Patton et al., 2012). However, evidence suggests that adolescent morbidity is actually a prelude to future population health, and health problems consolidated during adolescence can evolve to major determinants of adult health (Field et al., 2005). According to Kessler et al. (2005), five of the 'top ten' risk factors for the total disease burden stem from adolescence. Late adolescence in particular, appears to be "a window of vulnerability" (Steinberg,

2010), with undiagnosed or untreated diseases most likely being consolidated for life.

In reflection of this, one of the first longitudinal studies investigating early origins of adult obesity (Whitaker et al., 1997), demonstrated that more than 80% of overweight/obese adults were either overweight or obese at 17-years of age. Overweight at 17-years of age increases the risk for adult obesity (Guo et al., 2002), hypertension, type II diabetes, musculoskeletal pain, and overall obesity-related morbidity (Bar Dayan et al., 2005; Deere et al., 2012). Additionally, as a result of increased adiposity and low fitness levels, eutrophic adolescents exhibit higher inflammatory markers (Artero et al., 2010, 2014), increased cardiovascular risk factors (Freedman et al., 2007), high levels of depression and deviant peer affiliation (Lanza et al., 2015). All these evidence stress the importance of obesity research during late adolescence, in projecting the health of future adults and taking punctual action to tackle obesity. Additionally, late adolescence presents the final opportunity for the implementation of structured school-based

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interventions aiming to clamp down obesity rates and ensure future adult health.

Therefore, the aim of the present study was to assess the prevalence of underweight, normoweight, overweight, simple and central obesity in a representative sample of 17-year-old adolescents from Greece.

## 2. Subjects, materials and methods

### 2.1. Sample

Participants were recruited as part of the ADONUT study (Grammatikopoulou et al., 2014), a nationwide study on adolescent weight status and nutrition, conducted in Greece during the years 2010–2012. A total of 5759 17-year-olds (male/female ratio of 1.04) were selected via proportionate stratified random sampling. Details on the general characteristics of the sample are provided in Table 1. Approval was provided from the Directorate of Secondary Education, our Institute's Research Committee, the Greek Ministry of Education, as well as from the parents/guardians of the participants. The Alexander Technological Educational Institute's Research Committee funded the instruments used in the study. All collected data were handled according to the Helsinki Declaration.

### 2.2. Anthropometric measurements

Experienced and trained dietitians were involved in the anthropometric measurements. All measurements were taken during morning hours, at the participants' schools. Body weight (BW) and height were measured with Seca 874 portable digital scales and Seca 214 portable stadiometers (Seca GmbH & Co., Hamburg, Germany), respectively. Instruments were checked once per week for reliability and accuracy in the measurements. Body Mass Index (BMI) was calculated as BW (kg) divided by squared height (m<sup>2</sup>). Weight status was defined according to the BMI cutoffs endorsed by the International Obesity Task Force (IOTF) (Cole et al., 2000, 2007), and the prevalence of underweight, normal BW, overweight and obesity was diagnosed. The IOTF criteria were selected on the basis of increasing comparability between studies (Cole et al., 2007). Waist circumference was measured with a common measuring anelastic tape in a horizontal plane, midway between the inferior margin of the ribs and the top of the iliac crest, according to the World Health Organization (2008), and abdominal obesity was diagnosed in accordance to the International Diabetes Federation's endorsed criteria for Caucasian adolescents (Fernandez et al., 2004).

### 2.3. Statistical analyses

PASW Statistics 18.0 (SPSS Inc., Hong Kong) software was used for data analysis. Categorical values were compared with Chi-squared test and prevalence ratios (PR) were calculated, as suggested for cross-sectional studies (Santos et al., 2008a). Confidence intervals (CI) were set at 95% and *p* values smaller than  $\leq 0.05$  were considered significant. Maps were created with the use of GIMP 2.8.2 software for OS X.

## 3. Results

The majority of the study sample was normoweight (70.9%), 3.9% were underweight, 19.3% were overweight and the remaining 5.3% were classified as obese (Table 1). Simple obesity was apparent in 8.9% of the sample. Among geographical districts, underweight ranged from 2.6% in Crete, to 8.9% in central Greece.

**Table 1**  
Prevalence of each category of body weight, among 17 year-old boys and girls in Greece, according to geographical district of residence.

Geographical district	Boys						Girls																			
	N	Underweight	Normoweight	Overweight	Obese	N	Underweight	Normoweight	Overweight	Obese																
	n	%	CI	n	%	CI	n	%	CI	n	%	CI														
Thrace	134	4	3.0	0.1–5.9	89	66.4	58.3–74.5	32	23.9	16.6–31.2	9	6.7	2.4–11.0	203	9	4.4	1.6–7.3	67.8	80.0	33	16.3	11.1–21.4	9	4.4	1.6–7.3	
Macedonia	1484	40	2.7	1.9–3.5	919	61.9	59.5–64.4	393	26.5	24.2–28.7	132	8.9	7.4–10.3	1410	90	6.4	5.1–7.7	996	70.6	68.3–73.0	257	18.2	16.2–20.2	67	4.8	3.6–5.9
Epirus	278	14	5.0	2.4–7.6	195	70.1	64.7–75.6	55	19.8	15.1–24.5	14	5.0	2.4–7.6	305	26	8.5	5.4–11.7	227	74.4	69.5–79.4	38	12.5	8.7–16.2	14	4.6	2.2–7.0
Thessaly	292	7	2.4	0.6–4.2	172	58.9	53.2–64.6	86	29.5	24.2–34.7	27	9.2	5.9–12.6	262	21	8.0	4.7–11.3	189	72.1	66.7–77.6	39	14.9	10.6–19.2	13	5.0	2.3–7.6
Central Greece	469	30	6.4	4.2–8.6	278	59.3	54.8–63.7	126	26.9	22.8–30.9	35	7.5	5.1–9.8	321	40	12.5	8.8–16.1	214	66.7	61.5–71.9	51	15.9	11.9–19.9	16	5.0	2.6–7.4
Peloponnese	94	5	5.3	0.7–9.9	61	64.9	55.1–74.7	19	20.2	11.9–28.5	9	9.6	3.5–15.6	75	9	12.0	4.5–19.5	49	65.3	54.3–76.4	12	16.0	7.5–24.5	5	6.7	0.9–12.4
Ionian Islands	17	1	5.9	–6.6–18.4	13	76.5	54.0–99.0	3	17.6	–2.6–37.9	0	0.0	–	21	1	4.8	–5.2–14.7	15	71.4	50.4–92.5	3	14.3	–2.0–30.6	2	9.5	–4.2–23.2
Aegean Islands	132	4	3.0	0.1–6.0	74	56.1	47.5–64.6	45	34.1	25.9–42.3	9	6.8	2.5–11.2	186	14	7.5	3.7–11.4	122	65.6	58.7–72.5	31	16.7	11.3–22.1	19	10.2	5.8–14.6
Crete	37	0	0.0	–	27	73.0	58.0–88.0	6	16.2	3.8–28.7	4	10.8	0.3–21.3	39	2	5.1	–2.1–12.4	29	74.4	30.0–88.7	6	5.1	3.5–27.2	2	5.1	–2.1–12.4
Total	2937	105	3.6	2.9–4.2	1828	62.2	60.5–64.0	765	26.0	24.5–27.6	239	8.1	7.1–9.1	2822	212	7.5	6.5–8.5	1991	70.6	68.9–72.2	470	16.7	15.3–18.0	147	5.2	4.4–6.0

Statistically different compared to the boys of the same geographical district (\**p*  $\leq 0.05$ , \*\**p*  $\leq 0.01$ , \*\*\**p*  $\leq 0.001$ ).

CI: Confidence Intervals.

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