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The prevalence of abdominal obesity is remarkable for underweight and normal weight adolescent girls*

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Background/aim: Obesity is a global public health challenge. This study was carried out in order to determine the prevalence of obesity and abdominal obesity in Turkish adolescent girls.

Materials and methods: A cross-sectional study was conducted in a total of 1111 adolescent girls aged 12–18 years. The subjects were classified into four groups: underweight, normal, overweight, and obese. Abdominal obesity was defined according to waist circumference (WC) ≥ 90th percentile for Turkish adolescent population references (12–17 years) and waist-to-height ratio (WHtR) ≥ 0.5.

Results: The prevalence of underweight was 17.4%, normal weight 68.5%, overweight 12.1%, and obese 2.0%. A total of 16.9% subjects were abdominal obese based on WC and 10.4% based on WHtR. When the four groups were evaluated in terms of abdominal obesity status, prevalence was 6.4% and 2.6% in the underweight, 14.6% and 5.8% in the normal, 60.0% and 37.3% in the overweight, and 88.8% and 77.3% in the obese groups according to WC and WHtR, respectively. Both WC (r: 0.332) and WHtR (r: 0.156) were positively correlated with age ($P < 0.05$).

Conclusion: The prevalence of abdominal obesity was found at high levels for overweight and obese adolescents. It should be emphasized that abdominal obesity is a condition that should be considered for underweight and normal adolescents as well. Therefore, abdominal obesity should be regularly assessed for nonobese adolescents to prevent cardiovascular risks, metabolic syndrome, and other related disease.

Key words: Adolescents, abdominal obesity, waist circumference, waist–height ratio

1. Introduction

Childhood obesity is a global public health challenge. Consumption of unhealthy foods and beverages, sedentary lifestyles, and increasing urbanization lead to increased childhood obesity in developing and developed countries (1). Obesity prevalence is rapidly increasing among children and adolescents. Childhood overweight and obesity rates rose from 4.2% in 1990 to 6.7% in 2010 worldwide (2). The percentage of adolescents aged 12–19 years who were obese increased from 5% in 1980 to nearly 21% in 2012 in the United States (3). In Turkey the National Nutrition and Health Survey - 2010 reported that the total percentage of overweight was 27.3% and the total percentage of obesity was 18.5% in adolescents of both sexes aged between 12 and 18 years (4).

Overweight and obese children are prone to be obese in adulthood and to the development of diet-induced chronic diseases (5). Studies showed that the risk of adult obesity for obese children was higher than in nonobese children (5,6). In particular, abdominal obesity causes a wide range of serious complications such as cardiovascular disease (7), insulin resistance, type 2 diabetes mellitus (8), metabolic syndrome (9), and different types of cancers (10) in childhood and adolescence.

Body mass index (BMI) provides general information about obesity status. However, it is not sufficient for evaluation of the distribution of body fat. Increased upper body fat is indicative of visceral adiposity (11,12), which is recognized as a risk factor for many diseases (7–10). Waist circumference (WC) and waist-to-height ratio (WHtR) are sensitive and specific measurements both total and intraabdominal body fat (12,13). Increased WC is an important descriptor for the risk of diet-related chronic diseases (4). Moreover, WHtR is a simple, age- and sex-

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independent reference measurement that is related to cardiovascular risk factors and metabolic syndrome (14,15). The use of abdominal obesity measurements can identify individuals within the normal range of BMI who may have a higher metabolic risk (12,14,15).

This study was carried out in order to determine the prevalence of overall and abdominal obesity, by using together body mass index, measurements of waist circumference, and waist to height ratio in healthy Turkish adolescent girls.

2. Subjects and methods

2.1. Participants and study area

A cross-sectional study was conducted in a total of 1134 adolescent girls, aged between 12 and 18 years. Twenty-three of the participants were excluded due to lack of some measurements; therefore 1111 adolescents took part in the final investigation. Healthy adolescent subjects who had no chronic disease and no medication were recruited from four state middle schools and one state high school. A simple randomized sampling method was used for identifying schools from a district (of middle socioeconomic status) in Ankara, the capital of Turkey. The inclusion of subjects was on a voluntary basis; prior to acceptance, their parents were fully informed about the objectives and methods of the study. When the number of students in the school is taken into account (total 1394 girls), participation in the study was 81.3% and 79.7% were evaluated.

Adolescents and their parents signed a voluntary participation form and filled in questionnaires, which adhered to Declaration of Helsinki protocols (World Medical Association). The research protocol was approved by the Committee of Scientific Research in Gazi University, Faculty of Health Sciences (B011/17). The data were collected in face-to-face interviews by the researchers.

2.2. Measurements

The questionnaire applied includes some demographic characteristics of adolescence of the participants. Adolescence characteristics were questioned by researchers with respect to privacy.

All anthropometric measurements were recorded by trained dieticians with the participants wearing light clothes and no shoes. Portable scales were used to measure body weight to the nearest 0.1 kg, and height was measured to the nearest 0.1 cm with a fixed stadiometer. Waist circumference was measured above the iliac crest and below the lowest rib margin at minimum respiration with an inelastic flexible tape in a standing position (16). Hip circumference (HC) was measured at the maximum protuberance of the buttocks, and the waist to hip ratio (WHR) was calculated as waist circumference (cm) divided by hip circumference (cm). Body mass index was calculated as weight (kg) divided by height squared (m^2). The WHtR was calculated as waist circumference (cm) divided by height (cm).

The prevalence of overweight and obesity in adolescents was defined according to the WHO growth references for 5 to 19 year olds (http://www.who.int/growthref/en/). The subjects were classified into four categories of BMI for age z-score (BAZ): underweight (≤–2 SDs to –1 SD), normal (–1 SD to 1 SD), overweight (1 SD to 2 SD), and obese (≥2 SD) (17).

Abdominal obesity was defined according to WC ≥ 90th percentile for Turkish adolescent population references (aged 12 to 17 years) (18) and WHtR ≥ 0.5 (12).

2.3. Data analysis

The data were analyzed using SPSS version 13.0 (SPSS Inc., Chicago, IL, USA). The descriptive statistics of means with 95% CIs were used to summarize the data collected. Analysis of co-variance and post-hoc Tukey correction were used for multiple comparisons to determine anthropometric measurements according to BMI for age z-score classifications. A chi-square test was used to analyze the percentage of WC and percentage of WHtR according to the BAZ classifications. Pearson's correlation test was used to determine the relations between BMI and WC and WHtR according to the age groups. All of the percentiles were age-specifically calculated. In all analyses, 0.05 significance levels were used.

3. Results

3.1. General characteristics and overall obesity status

The age of the subjects ranged between 12 and 18 and mean age of the study population was 15.2 ± 1.74 years. Age was not significantly different between the four BMI groups. Overall, the prevalence of underweight subjects was 17.4%, of normal subjects was 68.5%, of overweight subjects was 12.1%, and of obese subjects was 2.0% according to BMI for age z-score (BAZ) classifications.

3.2. Evaluation of abdominal obesity

Mean anthropometric measurements of the subjects are shown in Table 1. Weight, BMI, WC, and WHtR were significantly different between the four groups ($P < 0.05$). Mean WC of the underweight subjects was 63.1 ± 5.94 cm, 67.7 ± 6.68 cm in normal, 75.5 ± 7.42 cm in overweight, and 86.5 ± 10.96 cm in obese subjects. The mean WHtR was 0.39 ± 0.04 in underweight, 0.43 ± 0.05 in normal, 0.48 ± 0.04 in overweight, and 0.53 ± 0.05 in obese subjects. Height of the overweight group was lower than that of the other groups ($P < 0.05$).

When assessing the prevalence of abdominal obesity in the entire population, it was found that 16.9% of subjects were abdominal obese based on WC ≥ 90th percentile and 10.4% based on WHtR ≥ 0.5. Abdominal obesity was higher based on WC than based on WHtR (data not shown in the table).

Table 1. Anthropometric measurements according to BMI for age z-score (BAZ) classifications.

	Underweight (17.4%)	Normal (68.5%)	Overweight (12.1%)	Obese (2.0%)	P
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Age (year)	15.1 ± 1.67	15.2 ± 1.74	15.1 ± 1.84	15.5 ± 1.85	0.782
Weight (kg)	42.4 ± 9.48[a]	50.8 ± 7.54[b]	60.8 ± 8.78[c]	83.7 ± 21.68[d]	0.000
Height (cm)	160.2 ± 9.48[a]	158.7 ± 8.49[a]	156.4 ± 8.50[b]	161.7 ± 11.99[a]	0.001
BMI (kg/m^2)	16.4 ± 1.15[a]	20.1 ± 1.72[b]	24.7 ± 1.54[c]	31.9 ± 7.52[d]	0.000
WC (cm)	63.1 ± 5.94[a]	67.7 ± 6.68[b]	75.5 ± 7.42[c]	86.5 ± 10.96[d]	0.000
HC (cm)	82.6 ± 6.41[a]	88.4 ± 8.0[b]	96.4 ± 8.92[c]	106.6 ± 11.49[d]	0.000
WHR	0.77 ± 0.07	0.77 ± 0.09	0.78 ± 0.05	0.81 ± 0.08	0.129
WHtR	0.39 ± 0.04[a]	0.43 ± 0.05[b]	0.48 ± 0.04[c]	0.53 ± 0.05[d]	0.000
[β][γ]WC ≥ 90th (%)	6.4[a]	14.6[b]	60.0[c]	88.8[d]	0.000
[γ]WHtR ≥ 0.5 (%)	2.6[a]	5.8[b]	37.3[c]	77.3[d]	0.000

[a,b,c,d] Different letters indicate statistically significant differences (P < 0.05)

[γ] Chi-square test

[β] Percent of WC ≥ 90th was calculated according to the Turkish adolescent population references (aged 12 to 17 years) n: 958

When the four groups were evaluated in terms of abdominal obesity status, prevalence was 6.4% and 2.6% in underweight, 14.6% and 5.8% in normal, 60.0% and 37.3% in overweight, and 88.8% and 77.3% in obese subjects according to WC and WHtR, respectively (Table 1).

There were significant correlations between height and waist circumference (r = 0.188, in the underweight group; r = 0.375, in the normal group; r = 0.644, in the overweight group; and r = 0.701, in the obese group; P < 0.05). The correlation between height and WC and WHtR is shown in Table 2. A significant negative correlation was found between height and waist to height ratio in the underweight and normal groups.

3.3. Relationship between BMI and WC and WHtR according to age

Age-specific correlations of BMI are shown in Table 3. There were significant positive correlations between BMI values and WC and WHtR in all ages. Both WC and WHtR were positively correlated with age (r = 0.332, P < 0.05; r = 0.156, P < 0.05, respectively) in all study group (data not shown in the table).

WC (F: 146.446, P < 0.05) and WHtR (F: 101.169, p< 0.05) were significantly different between the four groups.

Mean WC and WHtR values were highest in obese subjects in all ages (Table 3).

4. Discussion

The increase in the prevalence of obesity in children and adolescents is one of the most alarming public health issues facing the world today (19). According to the International Obesity Task Force (IOTF) report, at least 10% of school-aged children between 5 and 17 years are overweight or obese (20). Several local studies were performed in order to determine obesity prevalence in child and adolescent groups in Turkey (21–24). Studies conducted in different regions showed that the prevalence of overweight ranged between 8.8% and 12.7% and prevalence of obesity ranged between 1.2% and 6.5% for adolescent girls (21–27). Recent nationwide study results showed that overweight and obesity prevalence was 12.8% and 8.5% in Turkish adolescent girls aged between 12 and 14 years and between

Table 2. Correlation between height and waist circumference and waist to height ratio according to BMI classification.

BMI classification (n)		Height	
		r	P
Underweight (194)	WC*	0.188	0.00
	WHtR*	–0.413	0.00
Normal weight (761)	WC*	0.375	0.00
	WHtR*	–0.139	0.00
Overweight (134)	WC*	0.644	0.00
	WHtR	0.119	0.17
Obese (22)	WC*	0.701	0.002
	WHtR	0.217	0.33

*Correlation is significant P < 0.05

Table 3. Mean values of WC and WHtR and age-specific correlations of BMI.

Age		n	Underweight[a]	n	Normal weight[b]	n	Overweight[c]	n	Obese[d]	BMI	
										r	P*
12	WC (cm)	6	56.5 ± 2.53	42	60.6 ± 5.09	13	69.0 ± 5.26	1	77.0 ±0.0	0.750	0.000
	WHtR		0.39 ± 0.04		0.42 ± 0.04		0.47 ± 0.02		0.48 ± 0.0	0.611	0.000
13	WC (cm)	29	63.1 ± 5.38	84	64.8 ± 6.18	13	72.8 ± 8.39	3	84.67 ± 0.58	0.572	0.000
	WHtR		0.41 ± 0.04		0.43 ± 0.04		0.47 ± 0.05		0.54 ± 0.01	0.540	0.000
14	WC (cm)	46	63.2 ± 7.03	180	67.1 ± 6.22	29	72.8 ± 8.39	3	87.60 ± 18.04	0.531	0.000
	WHtR		0.40 ± 0.04		0.43 ± 0.04		0.47 ± 0.05		0.54 ± 0.06	0.612	0.000
15	WC (cm)	39	63.3 ± 5.58	163	67.9 ± 7.16	29	73.6 ± 5.21	3	86.33 ± 14.29	0.628	0.000
	WHtR		0.39 ± 0.04		0.42 ± 0.04		0.48 ± 0.03		0.54 ± 0.07	0.639	0.000
16	WC (cm)	28	64.1 ± 6.98	92	69.9 ± 6.18	23	76.4 ± 6.39	5	86.60 ± 2.88	0.658	0.000
	WHtR		0.39 ± 0.05		0.43 ± 0.04		0.47 ± 0.05		0.52 ± 0.03	0.699	0.000
17	WC (cm)	23	64.0 ± 5.37	93	70.4 ± 6.18	15	75.6 ± 6.39	3	100.0 ± 11.53	0.696	0.000
	WHtR		0.39 ± 0.04		0.43 ± 0.04		0.47 ± 0.03		0.58 ± 0.08	0.714	0.000
18	WC (cm)	23	61.8 ± 3.56	107	70.5 ± 6.64	19	79.5 ± 7.31	4	86.25 ± 10.34	0.457	0.000
	WHtR		0.37 ± 0.02		0.43 ± 0.07		0.49 ± 0.04		0.51 ± 0.04	0.500	0.000

Mean values were shown as mean ± standard deviation

[a,b,c,d] Different letters indicate statistically significant differences ($P < 0.05$)

* Correlation is significant $P < 0.05$.

13.0% and 8.2% in girls aged between 15 and 18 years (4). The prevalence of overweight (12.1%) in the present study is consistent with previous local and national studies. Although the prevalence of obesity (2%) in the present study is low compared to the National Study (4), it has shown compatibility with the results of local studies (21–24).

Both WC and WHtR were positively correlated with age. Strong positive correlations were found between WC, WHtR, and BMI in all age groups. The factor of age had an impact on BMI and the abdominal obesity markers, which were WC and WHtR. They increased with age. Similarly, a previous study reported that there was an upward trend in BMI, WC, and WHtR among females with increasing ages from 15 to 19 years (28). Another study found that when compared with children aged 2 to 5 years, those aged 12 to 18 years were more likely to be abdominally obese as defined by WC (odds ratio = 1.31) and WHtR (odds ratio = 1.27) (29).

Height is an important clinical indicator to derive BMI and WHtR (30). Height is positively associated with WC and may influence the observation of fat accumulation and/or distribution (30). Similar to Ortega et al.'s study (30), we found a significant positive correlation between height and WC in all groups in the present study. However, a negative correlation was found between height and WHtR for the underweight and normal groups, related to increasing height. These findings could be explained by the fact that WC-based prevalence of abdominal obesity is higher than WHtR-based prevalence in all groups (Table 1).

Body fat mass and fat distribution influence the risk of cardiovascular disease, and abdominal obesity is associated with metabolic disorders among children and adolescents. WC is easy to determine and is a useful measurement of fat distribution in children and adolescents (31). WC may be useful to characterize a population in terms of abdominal fat distribution and to determine the prevalence of risk factors and also in clinical practice to determine response to weight control measures in children and adolescents. On the other hand, waist circumference cannot be used to categorize a child as being at high or low risk (20). WHtR has been shown to be a simple, noninvasive, and practical tool that correlates well with visceral fat (32). Both WC and WHtR have been found to be indicators of high abdominal fat mass and powerful markers associated with a number of cardiovascular risk factors and metabolic syndrome in epidemiologic studies (30–32).

Statistically significant differences were found for weight, height, WC, and WHtR among the underweight, normal, overweight, and obese groups in the present study.

Moreover, mean WC and WHtR were significantly higher in overweight and obese subjects than in underweight and normal subjects. WC and WHtR were correlated with BMI in all age groups. Furthermore, WC and WHtR values increased in parallel with BMI. In addition to obesity, elevated WC and WHtR values are indicators to determine the health risks of adolescents.

Studies have shown that the percentage of body fat increases in adolescence, especially in girls from 6 to 18 years of age (33,34). McCarthy et al. reported the abdominal obesity prevalence based on WHtR was 11.7% in 11- to 16-year-old girls (32) and Graves et al. indicated an abdominal obesity rate of 22.9% in adolescent girls who had WHtR ≥ 0.5 (7). Another study assessing abdominal obesity in the US revealed that abdominal obesity prevalence was 18.78% defined by WC and 35.59% defined by WHtR among adolescents aged 12 to 18 years in 2011–2012 (29). Rafraf et al. found that abdominal obesity prevalence was 13.2% based on WC and 18.2% based on WHtR in adolescent girls (35). Abdominal obesity prevalence was 15.2% based on WC and 15.6% based on WHtR in Lebanese adolescent girls aged 12 to 19 years old (36). In the present study, 16.9% of subjects were abdominal obese based on WC and 10.4% based on WHtR. The prevalence of abdominal obesity in the present study was lower than that from other studies mentioned above (7,29,35). When assessing the prevalence of abdominal obesity in the entire population in the present study, it was found that the percentage of abdominal obesity based on WC was higher than that based on WHtR in total (data not shown in table) and all groups (Table 1), similar to other countries' results such as the US (29) and Lebanon (36).

Consistent with other studies (29,35,36), the majority of the overweight and obese adolescents were abdominal obese according to WC (overweight 60%; obese 37.3%) and WHtR (overweight 88.8%; obese 77.3%). However, most studies have not reported abdominal obesity status for adolescents with normal BMI and underweight subjects. One study reported the percentage of abdominal obesity was 2.9% and 6.1% based on WC and WHtR, respectively, in adolescent girls with normal BMI (35). The most important finding of this study is the fact that it is different from other studies because abdominal obesity was found in underweight and normal adolescents as well. In the present study, the prevalence of abdominal obesity for girls with normal BMI was 14.6% according to WC and 5.8% according to WHtR. It was notable that this rate was higher than that in the study mentioned above (35). Furthermore, the prevalence of abdominal obesity for underweight girls was 6.4% and 2.6% based on WC and WHtR, respectively. Other studies did not indicate abdominal obesity for underweight adolescents. Using only BMI in order to assess obesity can lead to critically important information being missed. Previous cross-sectional and prospective studies showed elevated WC and WHtR were predictors of intraabdominal adiposity (11,37). Even if the individuals are not obese according to BMI, abdominal obesity can be seen. In addition, many studies indicate that presence of abdominal obesity is a potential risk for cardiovascular and metabolic diseases such as dyslipidemia, hypertension, type 2 diabetes, and metabolic syndrome (38–40). The prevalence of abdominal obesity is remarkable for underweight and normal adolescent girls as well as overweight and obese ones. Regardless of obesity status, abdominal obesity should be evaluated regularly for adolescents. It will provide opportunities for determination of the risks at an early stage and for early intervention.

In conclusion, overweight and obesity are an important challenge for healthy Turkish adolescent girls. Adolescent obesity is a significant public health issue often associated with a range of health problems. Similar to previous studies, the prevalence of abdominal obesity was found at high levels for overweight and obese adolescents. It should be emphasized that abdominal obesity is a condition that should be considered for underweight and normal adolescents. In accordance with these results, abdominal obesity should be regularly assessed for nonobese adolescents to prevent cardiovascular risks, metabolic syndrome, and other related disease. High abdominal obesity in this age group will cause an epidemic of adult obesity and related complications, with a well-known social and economic burden of disease in the future. Appropriate intervention is needed to prevent adolescent obesity. Determination of the prevalence of obesity and abdominal obesity is important both at the individual level and in terms of public health management. In order to combat obesity, efforts are being made to develop national policies. National health policy should be focus on healthy nutrition, regular physical activity, and improvement of life style for adolescents and their families.

5. Limitations

The present study has a limitation. Although the study has a large population, the samples should not be representative at national level. Nevertheless, the results of this study can shed light for further national and/or international studies.

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