



Original/*Obesidad*

Prevalence of underweight, overweight, general and central obesity among 8-15- years old Bulgarian children and adolescents (Smolyan region, 2012-2014)

Silviya Mladenova¹ and Emiliya Andreenko²

¹Plovdiv University "Paisii Hilendarski"- Branch Smolyan, Department of Natural-Mathematical and Economical Sciences.

²Plovdiv University "Paisii Hilendarski", Biological faculty, Department of Human Anatomy and Physiology. Bulgaria.

Abstract

Objective: the objective of this work is to investigate the distribution of underweight, overweight, the general and central obesity in 8-15-year-old Bulgarian children and adolescents, through the use of the anthropometric indices BMI and WHtR.

Materials and methods: subject of this study are 878 children and adolescents (437 boys and 441 girls) of Smolyan region, Bulgaria, at the age of 8 to 15 years. The study is cross-sectional and was conducted in the period 2012-2014. The body height, weight and waist circumference were measured. In addition, the body mass index (BMI) and waist to height ratio (WHtR) were calculated. Overweight and obesity were defined according to the cut-off points of BMI, recommended of IOTF and developed by Cole et al. (2000; 2007). The central obesity was defined according to the discriminatory values of 0.500 of WHtR. The collected data were analysed by statistical software packages STATISTICA 10.0 and SPSS 16.

Results: overweight occurs among 18.8 % of the boys and 17.0 % of the girls, and obesity occurs among 7.6 % of boys and 3.7 % of the girls. The underweight are 8.0 % of the boys and 10.4 % of the girls. Central obesity (WHtR \geq 0.500) occur among average 12.75 % of all investigated children independently of their nutritional status (16.2 % of boys and 9.3 % of girls). With central obesity (WHtR \geq 0.500) are on average 2.7% of all boys and girls with normal weight (n = 96) and an average 46.82% of all participants with overweight and with obesity (n = 205). With increased health risk (WHtR \geq 0.500) are total of 2.01% (n=16) of all surveyed children (n = 793) from categories normal weight.

Conclusion: there has been an increase in prevalence of overweight and obesity among Bulgarian children and adolescents from Smolyan region during the over one last decade. The relatively high percentage of underweight children, especially among in group of the girls after

PREVALENCIA DE BAJO PESO, SOBREPESO, OBESIDAD CENTRAL Y GENERAL ENTRE 8-15 AÑOS DE EDAD LOS NIÑOS BÚLGAROS Y ADOLESCENTES (REGIÓN DE SMOLYAN, 2012-2014)

Resumen

Objetivo: el objetivo de este trabajo es investigar la distribución de peso insuficiente, demasiado pesado, la obesidad general y central en 8 niños búlgaros de 15 años y adolescentes, a través del uso de los índices antropométricos BMI y WHtR.

Materiales y métodos: el objeto de este estudio son 878 niños y adolescentes (437 niños y 441 niñas) de la región de Smolyan, Bulgaria, con edades de 8 a 15 años. El estudio es transversal y se llevó a cabo en el período 2012-2014. Se miden la altura, el peso y la circunferencia de la cintura, así como el índice de masa corporal. El sobrepeso y la obesidad se definen de acuerdo con los puntos de corte de BMI, recomendado por la IOTF y desarrollado por Cole et al. (2000:2007). La obesidad central fue definida de acuerdo con los valores discriminatorios de 0,500 de WHtR. Los datos obtenidos fueron analizados por los paquetes de software estadístico STATISTICA 10.0 y SPSS 16.

Resultados: el sobrepeso se produce entre el 18,8% de los chicos y el 17,0% de las niñas, y la obesidad entre el 7,6% de los varones y el 3,7% de las chicas. Presentan bajo peso el 8,0% de los chicos y el 10,4% de las chicas. La obesidad central (RCEst \geq 0.500) se produce en promedio, en el 12,75% de todos los niños investigados, independientemente de su estado nutricional (16,2% de los varones y el 9,3% de las chicas). Presentan obesidad central (RCEst \geq 0.500), en promedio, el 2,7% de todos los niños y niñas con peso normal (n = 96) y un promedio 46,82% de todos los participantes con sobrepeso y con obesidad (n = 205). Con el aumento de riesgo para la salud (RCEst \geq 0.500) son total de 2,01% (n = 16) de todos los niños encuestados (n = 793) de las categorías de peso normal.

Conclusión: se ha producido un aumento de la prevalencia de sobrepeso y obesidad en niños y adolescentes búlgaros de la región de Smolyan durante más de una década. El porcentaje de insuficiencia ponderal entre los niños, es relativamente alto especialmente entre el grupo de las niñas después de la pubertad. La obesidad central,

Correspondence: Silviya Mladenova.

Department of Natural-Mathematical and Economical Sciences, 32 Dicho Petrov Str., 4700 Smolyan, Bulgaria, E-mail: silvia_mladenova@mail.bg

Recibido: 5-II-2015.

1.ª Revisión: 3-III-2015.

Acceptado: 12-III-2015.

puberty. The central obesity, as well as its combination with overweight or general obesity is more frequent in boys than in girls.

(*Nutr Hosp.* 2015;31:2419-2427)

DOI:10.3305/nh.2015.31.6.8805

Key words: *BMI. WHtR. Underweight. Overweight. Obesity. Central obesity. Children and adolescents.*

Abbreviations

BMI: Body mass index.

WHtR: Waist to height ratio.

NS: Nutritional status.

IOTF: International Obesity Task Force.

WHO: World Health Organization.

Introduction

Overweight and obesity are some of the most pressing challenges that humanity faces today. In literature, obesity ranks second only to smoking as a cause of premature death and a risk factor for development of cardiovascular diseases and metabolic disorders in adult and children¹⁻². The relative proportion of children with overweight and obesity in the world as well as in Bulgaria is on the increase³⁻⁶. According to the World Health Organization Bulgaria has one of the highest rates of mortality of the population (66 %) as a result of cardio-vascular diseases, whose etiology is associated with major behavioral risk factors such as smoking and lack of exercise, and metabolic risk factors such as high blood pressure, overweight and obesity⁷.

Worldwide, the most commonly used anthropometric measurement for diagnosis of both obesity and underweight is body mass index (BMI). But this index is not a panacea and its use has received a lot of criticism due to the fact that it is only a height/weight ratio, it does not give a very accurate idea which of the components of the body weight is responsible for the accumulation of body mass⁸. Another anthropometric indicator for assessment of obesity which has been recently used more frequently is the ratio between the waist circumference and height (WHtR). This indicator is a specific sensitive marker of fat accumulation in the upper part of the body and is also used for the assessment of the risk of some cardiovascular diseases and metabolic disorders associated with the central accumulation of fats⁹⁻¹⁰. According to a number of studies, WHtR correlates to a great extent with the risk of cardiovascular and metabolic diseases both in adults and children; thus it may be used as an alternative, universal, convenient, and inexpensive tool for the assessment of central obesity in clinical practice due to its independence of gender and age^{8,10,11-13}. Several authors think that the WHtR is even a more sensitive

así como su combinación con el sobrepeso o la obesidad, es más frecuente en niños que en niñas.

(*Nutr Hosp.* 2015;31:2419-2427)

DOI:10.3305/nh.2015.31.6.8805

Palabras clave: *BMI. WHtR. Bajo peso. Sobrepeso. Obesidad. Obesidad central. Niños y adolescentes.*

diagnostic indicator of overweight and obesity in children as compared with the BMI^{10,12,14}. The data for the distribution of overweight and obesity are important not only for science and for clinical practice, but also for the economy of any country.

In this regard, the **objective** of this work is to investigate the distribution of underweight, overweight, and the general and central obesity among the contemporary generation of 8-15-year-old Bulgarian children and adolescents (Smolyan region), through the use of the anthropometric indices BMI and WHtR.

Material and methods

Sampling technique. The subjects of this study are 878 children and adolescents, aged from 8 to 15 years, of which 437 boys and 441 girls. The study is cross-sectional and was carried out in the period 2012-2014 at eight public schools in Smolyan region, Bulgaria. The children and adolescents are distributed in eight age groups, the grouping carried out by Martin's method. Thus, for example, the group of 10-year-olds included children from the age of 9 years, 6 months and 0 days to 10 years 5 months and 29 days (Table I).

Study design. The study design included three directly measured anthropometric indices - height (cm), weight (kg) and waist circumference (cm). On this base two additional indexes were calculated - body mass index (BMI, kg/m²), and waist to height ratio (WHtR).

The anthropometric measurements were carried out under the classical methodology of Martin-Saller¹⁵. The height was measured with original anthropometer with an accuracy of 1 mm ("GPM Antropologische Instrumente"). The weight was measured with the analyzer of body composition "Tanita BC 453" with a precision of 0,05 kg. The waist circumference was measured with millimetre line with an accuracy of 1 mm.

Evaluation of body nutritional status was made according to cut-off points of BMI for children from 2 to 18 years, recommended of International Obesity Task Force (IOTF) and developed by Cole et al.¹⁶⁻¹⁷. The four groups of children were separated- underweight, with normal weight, overweight and obese.

For evaluation of central obesity the discriminatory values of 0.500 for WHtR were used. The two groups of children were separated -the first group included children with WHtR < 0.500 i.e without central obesity, and the second group included children with WHtR

≥ 0.500 i.e. with central fat distribution and central obesity¹⁰.

Statistical analysis. The collected data were analysed by statistical software packages STATISTICA 10.0 and SPSS 16. Mean and standard deviation for each of the anthropometric measurements and indexes were calculated. Also the frequency distribution of children of each sex and age into BMI and WHtR categories was made. The statistical significance between age- and sex groups was evaluated through T-test of Student on p-level 0.05. The evaluation of differences between groups of children according to categories of body nutritional status and WHtR was made by χ^2 criteria on p-level 0.05.

Results

Data on the distribution of subjects participating in the study according to age and their gender are presented in Table I.

Table II presents the statistical characteristics of BMI and WHtR (mean, standard deviation, and significance of inter-age and inter-sex differences), according to age and sex.

The values of the BMI rise during the growth. The mean value of the BMI for 8-year-old boys is 17.2 ± 2.7 kg/m², while with the 15-year-olds it is 21.6 ± 3.9 kg/m². As for the girls, the values of BMI increase from 16.5 ± 2.1 kg/m² with the 8-year-olds to 20.5 ± 3.2 kg/m² with the 15-year-old girls. In both sex groups the values of BMI increase insignificantly ($p > 0.05$) in the all age period, with the exception of the period 9th-10th year of age when 10-year-old girls have statistically significantly highest BMI values ($p < 0.05$) than 9-year-old girls.

The boys have higher values of the BMI than girls in all ages with the exception of the period 11th-13th year

Age (years)	Boys (n)	Girls (n)
8	55	50
9	69	62
10	65	70
11	51	69
12	64	55
13	62	49
14	36	50
15	35	36
TOTAL:	437	441

of age when both sexes have the same value of this index. During the whole period, however, no statistically significant differences between the sexes ($p > 0.05$). For both sexes, the greatest accumulation of body mass per unit of height was observed between 9th-10th year of age and the 13th-14th year of age, i.e. in the period of pre-puberty and puberty.

Unlike the BMI, the values of WHtR gradually decreased over the period of survey. Thus, the average value of the ratio is 0.454 ± 0.03 for the 8-year-old boys. Up to the 10th year of age, these values increase to 0.464 ± 0.05 , then follow decreases and in the 15th year of age to 0.435 ± 0.04 . With the 8-year-old girls, WHtR is 0.445 ± 0.03 respectively, and increases to 0.450 ± 0.04 with the 10-year-olds. After that, WHtR decreases in the same way as with the boys, and at the end of the period it reaches values of 0.424 ± 0.05 . In

Table II
Statistical data of body mass index (BMI, kg/m²) and waist to height ratio (WHtR) of participants according to their age and sex

	Boys							Girls							Intersex differences					
	N	Mean	SD	IAD	p	Mean	SD	IAD	p	N	Mean	SD	IAD	p	Mean	SD	IAD	p		
8	55	17.2	2.7			0.454	0.03			50	16.5	2.1			0.445	0.03			0.14	0.16
9	69	17.6	3.2	0.46		0.458	0.04	0.67		62	17.1	2.6	0.18		0.444	0.03	0.85		0.32	0.04*
10	65	18.7	3.4	0.06		0.464	0.05	0.49		70	18.4	3.4	0.01*		0.450	0.04	0.38		0.65	0.11
11	51	18.7	4.1	0.92		0.445	0.06	0.07		69	18.7	3.4	0.67		0.436	0.05	0.07		0.93	0.35
12	64	19.3	3.8	0.36		0.442	0.05	0.80		55	19.0	2.9	0.61		0.428	0.05	0.34		0.61	0.11
13	62	20.0	4.3	0.33		0.445	0.06	0.82		49	19.9	4.3	0.20		0.428	0.05	0.97		0.90	0.14
14	36	20.9	3.6	0.29		0.437	0.05	0.49		50	20.1	2.9	0.82		0.418	0.03	0.23		0.20	0.03*
15	35	21.6	3.9	0.47		0.435	0.04	0.84		36	20.5	3.2	0.53		0.424	0.05	0.54		0.18	0.31

Note: N-number, Mean-average value, SD-standard deviation, IAD- inter-age differences; ISD – inter-sex differences; p- level of significance, * $p < 0.05$.

both sex groups the values of WHtR decreases insignificance ($p > 0.05$) in the all age period.

The boys have insignificance higher values of the WHtR than girls in all ages, with the exception of the 9th and 14th year ($p < 0.05$), when the values of WHtR of boys are significance higher than in girls.

In Table III are present the results of the percentage distribution of the children and adolescents being surveyed according to the different type of body nutritional status.

The results showed that of the all surveyed 878 children and adolescents of both sexes 32.7 % have deviations from normal body nutritional status- 9.2 % of all are underweight, 17.9% are overweight, and 5.6% are obese. The distribution according to sex showed that 65.6 % of the boys have normal body nutritional status, 8 % are underweight, 18.8% are overweight and 7.6 % are obese. 67.3% of all investigated boys and girls have normal weight.

In group of the boys 65.6 % of all surveyed are with normal weight, 8.0 % are underweight, 18.8 % are overweight and 7.6 % are obese. In terms of age dis-

tribution, the results show that the highest percentage of underweight boys is observed at the 11th (15.8 %), the 13th (12.9 %) and the 14th year of age (11.1 %). Overweight has the highest share among 10-year-olds (24.6 %), the 14-year-olds (27.8 %), and most often obesity occurs with 11-year-olds (11.9 %).

As for the girls, the results showed that 68.9 % are with normal weight, 10.4 % are underweight, 17.0 % are overweight and 3.7 % are obese. Underweight is most commonly encountered in 15-year-old girls, when it reaches 22.2 %; overweight is more often occurs between the 10th-12th year of age (20.0-23.6 %) and obesity in the 13th year of age (6.1 %).

Table IV presents the results for the percentage distribution of the children and adolescents in different categories of WHtR.

With the all boys and girls, normal fat distribution ($WHtR < 0.500$) is observed average among 87.3 % of the all participants, while with abnormal central fat distribution and central obesity ($WHtR \geq 0.500$) are average 12.7 % of all investigated boys and girls ($WHtR \geq 0.500$). The highest average percentage cen-

Table III
Prevalence of different categories body nutritional status in boys and girls. according to their ages based on IOTF BMI cut-off points (Cole et al. 2000; 2007)

Age (years)	Underweight		Normal weight		Overweight		Obese		Total	
	n	%	n	%	n	%	n	%	n	%
Boys										
8	1	1.8	40	72.7	10	18.2	4	7.3	55	100
9	6	8.7	46	66.7	12	17.4	5	7.2	69	100
10	3	4.6	42	64.6	16	24.6	4	6.2	65	100
11	8	15.8	30	58.8	7	13.7	6	11.7	51	100
12	4	6.2	44	68.8	12	18.8	4	6.2	64	100
13	8	12.9	40	64.5	8	12.9	6	9.7	62	100
14	4	11.1	20	55.5	10	27.8	2	5.6	36	100
15	1	2.9	25	71.4	7	20.0	2	5.7	35	100
All	35	8.0	287	65.6	82	18.8	33	7.6	437	100
Girls										
8	4	8.0	38	76.0	7	14.0	1	2.0	50	100
9	7	11.3	43	69.4	10	16.1	2	3.2	62	100
10	4	5.7	48	68.6	14	20.0	4	5.7	70	100
11	8	11.6	42	60.9	15	21.7	4	5.8	69	100
12	5	9.1	36	65.5	13	23.6	1	1.8	55	100
13	4	8.2	37	75.5	5	10.2	3	6.1	49	100
14	6	12.0	38	76.0	5	10.0	1	2.0	50	100
15	8	22.2	22	61.1	6	16.6	0	0.0	36	100
All	46	10.4	304	68.9	75	17.0	16	3.7	441	100
TOTAL	81	9.2	591	67.3	157	17.9	49	5.6	878	100

Table IV
Distribution (%) of participants in different categories of waist to height ratio (WHtR) by age and sex

Age (years)	8 y.	9 y.	10 y.	11y.	12 y.	13 y.	14 y.	15 y.	All
Boys	(n=55)	(n=69)	(n=65)	(n=51)	(n=64)	(n=62)	(n=36)	(n=35)	(n=437)
WHtR < 0.500 (%)	89.1	85.5	76.9	82.4	82.8	82.3	85.2	91.4	83.8 (366)
WHtR ≥ 0.500 (%)	10.9	14.5	23.1	17.6	17.2	17.7	14.8	8.6	16.2 (71)
Girls	(n=50)	(n=62)	(n=70)	(n=69)	(n=55)	(n=49)	(n=50)	(n=36)	(n=441)
WHtR < 0.500 (%)	92.0	91.9	82.9	88.4	90.9	91.8	100.0	91.7	90.7 (400)
WHtR ≥ 0.500 (%)	8.0	8.1	17.1	11.6	9.1	8.2	0.0	8.3	9.3 (41)
TOTAL	(n=105)	(n=131)	(n=135)	(n=120)	(n=119)	(n=111)	(n=86)	(n=71)	(n=878)
WHtR < 0.500 (%)	75.5	88.7	79.9	85.4	86.8	87.1	92.6	91.6	87.3 (766)
WHtR ≥ 0.500 (%)	9.5	11.3	20.1	14.6	13.2	12.9	7.4	8.4	12.7 (112)

tral obesity is observed among 10-year-olds (20.1 %) children.

In group of boys, normal fat distribution (WHtR < 0.500) is observed among 83.8 % of the all participants surveyed. 16.2 % of the boys have central accumulation of fat i.e central obesity (WHtR ≥ 0.500). The percentage of central obesity among boys various from 8.6 % to 23.1 % during investigated age period.

With the girls the results are as follows: a total of 90.7 % are without central obesity (WHtR < 0.500) and 9.3% have central obesity (WHtR ≥ 0.500). The

percentage of central obesity among girls is lower than in boys in all age groups, and various between 0.0 % to 17.1 %. The highest proportion of girls with central obesity is observed among 10-year-olds girls also. (17.1 %).

As far as age is concerned, the percentage of adolescents of both sexes with central obesity (WHtR ≥ 0.500) significantly increases between the 9th-10th year of age: ranging from 14.5 % to 23.1 % in boys, and from 8.1 % to 17.1 % in girls.

Table V presents the results of the prevalence of WHtR categories in children and adolescents accor-

Table V
Prevalence (%) of WHtR categories in children and adolescents according to their body nutritional status

BMI categories	Numbers with WHtR < 0.500 n (%)	Numbers with WHtR ≥ 0.500 n (%)	Total in BMI categories n (%)	% of participants at risk by WHtR, but without risk according to BMI	% of participants at risk by BMI, but without risk according to WHtR
Boys					
Normal weight	278 (97.2 %)	8 (2.8 %)	286 (100 %)	1.99 % (8/401)	
Overweight	49 (59.8 %)	33 (40.2 %)	82 (100 %)		12.2 % (49/401)
Obese	3 (9.1 %)	30 (90.9 %)	33 (100 %)		0.75 % (3/401)
Girls					
Normal weight	294 (97.4 %)	8 (2.6 %)	302 (100 %)	2.04 % (8/392)	
Overweight	54 (72 %)	21 (28 %)	75 (100 %)		13.8 % (54/392)
Obese	3 (20 %)	12 (80 %)	15 (100 %)		0.76 % (3/392)
All					
Normal weight	572 (97.3%)	16 (2.7 %)	588 (100 %)	2.01% (16/793)	
Overweight	103 (65.6%)	54 (34.4 %)	157 (100 %)		12.98 % (103/793)
Obese	6 (12.5 %)	42 (87.5 %)	48 (100 %)		0.75 % (6/793)
TOTAL (excludes 81 children with underweight)	681 (85.9 %)	112 (14.1%)	793 (100 %)		

Note: WHtR < 0.500 - without central obesity; WHtR ≥ 0.500 - with central obesity.

ding to their nutritional status. The table does not include data for 81 boys and girls who are underweight.

Without central obesity (WHtR < 0.500) are total 85.9 % of all participants with normal weight, overweight and obesity (n=793) and with central obesity (WHtR ≥ 0.500) are total 14.1 % of all boys and girls.

In group of children and adolescents with normal weight the values of WHtR < 0.500 i.e. without central obesity are on average 97.3 % of all 588 girls and boys in this group (97.2 % of boys and 97.4 % of girls) and with central obesity (WHtR ≥ 0.500) are on average 2.7% (2.8 % of boys and 2.6 % of girls). In group of children with overweight on average 34.4 % of participants from both sexes all are with central obesity (40.2 % of the boys and 8% of the girls). Among group of obese participants average 87.5 % are with simultaneously general and central obesity (90.9 % of the boys and 80 % of the girls).

Generally with central obesity (WHtR ≥ 0.500) are total 2.7 % (n=16) of all surveyed (n=588) children with normal status according BMI criteria, and average 46.82 % (n =96) of children who are overweight and obese (n=205).

The percentage of children from both sexes at risk according to IOTF BMI criteria, but without risk according to WHtR criteria are total 13.73 % (n = 109) of 793 (100 %) participants. In other hand, the percentage of children at risk according to WHtR investigated children with normal nutritional status.

Discussion

The average values of BMI of contemporary generation of children and adolescents obtained in the present study are higher compared to those of children and adolescents from the region examined by the leading author in the period 1999-2001¹⁸. The BMI of the boys surveyed is 1.3 to 2.6 index units (IU) higher in the period from the 8th to the 14th year of age as compared with that of their peers from more than a decade ago. There are practically no differences only in the age group of 15-year-old boys. The trend is similar for the girls: the girls surveyed have BMI which is higher by 0.4 to 2.5 IU than that of girls their age during the period from the 9th to the 15th year of age. The girls from the two generations have almost identical values of the index only in their 8th year.

According to the our results obtained, the values of WHtR increase between the 8-10 year in both sexes, then follows a gradual fall until the 15th year of age (Table II). This fact is due to the different growth rate of height and waist circumference in this period. This our results confirmed the results of Mc Carthy, Ashwell¹⁰ for British children and adolescents. In addition, our results also confirmed earlier obtained data for lower values of WHtR in girls¹⁰, which is due to their lower height during a greater part of the period, as well

as to their smaller waist circumference, especially in their 14th-15th year.

The our results about prevalence of different types of body nutritional status among contemporary generation Smolyan's children and adolescents, Bulgaria (Table III) show increase of prevalence of overweight and obesity during the period 2001 to 2014, based on the old data of nutritional status in children from the same region¹⁸. From 12.9 % in 2001 the overweight increase to 17.9 % in 2014. Obesity has increased from 3.1 % to 5.6 % between 2001-2014. These our findings confirm other authors' data showing an increase in the percentage of Bulgarian children and adolescents with overweight and obesity in different periods of growth^{5, 19-20}, as well as an increase in the percentage of children with overweight and obesity in other countries of Europe and the world^{3-4,6, 21-23}.

The results on the distribution of the various categories of nutritional body status showed that the frequency of occurrence of underweight in 8-15-year-old Smolyan adolescents of both sexes was slightly higher than that of Plovdiv's children and adolescents while the frequency of occurrence of overweight and obesity is lower than that of Plovdiv's children and adolescents¹⁹.

The present our results do not confirm the data from the National survey of the nutritional status of students in Bulgaria made by Konstantinova et al. in 2011, the results of which are cited in the report of WHO for Bulgaria "Nutrition, Physical activity and Obesity. Bulgaria"²⁴, in which it is reported that overweight among Bulgarian boys aged 10 to 13 years is 38.3%, while among girls it is 30.1 %. Obesity in the 10-13-year-old adolescents, according to data from this report is 17.1 % for boys and 10.8 % for girls²⁴. Our results showed a lower percentage of overweight and obesity, estimated on the basis of the discriminatory values for BMI of IOTF¹⁶⁻¹⁷ for Bulgarian adolescents of both genders in this and other age periods. Similar results about the lower percentage of Bulgarian children and adolescents with weight and obesity are finding from other Bulgarian anthropologists^{19-20,25-26}.

At the same time, a lower percentage of overweight and obesity has been observed in the Bulgarian children and adolescents examined, and a slightly higher percentage of underweight as compared to those in the 7-14-year-old peers from Kisela Voda municipality, Macedonia according to Gontarev and Kalac²². The our results for overweight and obese Bulgarian children are lower compare of those for the Greek adolescents, aged from 12 to 15 years²³.

The children and adolescents examined by us have similar distribution of overweight and obesity to that of their peers from Jagodina, Central Serbia²⁷. Thus, in the period from the 8th – 15th year, the average incidence of occurrence of overweight among Serbian boys (21.5 %) is only 2.7% higher than that of our boys (18.8 %), while obesity among Serbian boys (6.2 %)

is, on the average, only 1.4% less than that of the Bulgarian boys (7.6 %). The tendency is similar with the girls - overweight among Serbian 8-15-year-old girls (19.4 %) is, on average, more frequently distributed, by 2.2 % than that among the Bulgarian girls (17.1 %), while obesity is more frequent, by 2.4 % respectively. More significant differences between the two groups of children have been observed in the distribution of overweight and obesity in the different ages.

Also, independently of some differences in the age of the investigated persons it appears that in Bulgaria the percentage of children and adolescents with overweight and obesity is similar to this percent for children and adolescents from Ankara, Turkey²⁸, higher than in China²⁹ and Brazil³⁰, but lower than in the United States⁶.

Differences in the distribution of underweight and overweight among the various territorial groups of Bulgarian children and adolescents, as well as between them and their peers from other countries are associated with genetic differences and differences in their eating habits, physical activity, the quality and style of life, as well as in the socio-economic status of their families.

Our results in terms of body nutritional status have also shown that the greatest percentage of surveyed individuals with underweight, overweight and obesity has been observed among the 10-11 and 13-14-year-old boys and among the 10-15-year-old girls, i.e. in the period of the pre-puberty and puberty. Similar trends are reported by other authors^{22-23,25-27,31}.

In both sexes, these periods coincide with pre-puberty and puberty changes in the body, with great hormonal changes that affect the body composition and morphology. Understandably, the increase of the percentage of adolescents with underweight and overweight in the pre-puberty and puberty periods are associated with the hormonal changes accompanying the growth, and with the differences in eating habits, physical activity, socio-economic status of the families as well as with the way of life. In Bulgaria, as in the developed countries, the modern "urban" lifestyle has become the predominant trend in the family. In their hectic daily routine, preoccupied with their work, parents and especially mothers spend less time in preparing homemade food and providing healthy nutrition for their children. Nowadays, Bulgarian students spend the greater part of the day in school, eating mainly fast food, purchased at the school, such as pizza, hot-dog, sandwiches, crisps, snacks, waffles, biscuits, chocolates, soft drinks. This is one of the main reasons for the increased incidence of overweight and obesity among Bulgarian children³². Moreover, another important reason for this alarming trend is hipodynamics. Children spend increasingly less time in outdoor sports and physical activities at the expense of time spent in front of the computer and TV³². Similar trends as reasons for the increase in the incidence of overweight and obesity are reported by other authors³³.

Another trend observed in this study is the increase of the frequency of occurrence of underweight simultaneously with overweight and obesity among children and adolescents studied. Throughout the whole age period, the percentage of underweight boys generally varies from 1.8 % to 8.6 % until the 10th year, reaching 15.7 % in the 11th year. With the girls, the greatest number of underweight cases is observed in the 9th, 11th, 14-15th year of age, and the highest the percentage of underweight, a total of 22.4 % has been observed in 15-year-old girls. In both sexes, during these periods the intensive growth velocity and pre-puberty and puberty "jump" of height and weight are observed which are connected with changes in the body composition. Another significant reason for the high percentage of girls with underweight in the period of their 14-15th year is their desire to be slim and their wish to follow fashion trends and to look up to their fashion idols. Other authors report similar trends as well³⁴.

Our findings showing an increase of the frequency of occurrence of students with underweight are confirmed by the results of other authors^{19-20,25-26,31}.

Another important result of this study is the more frequent distribution of overweight and obesity in boys, which is observed to occur in all age periods. These results confirm earlier received similar data for Macedonia²², Greece²³, China²⁹, as well as for children from other Bulgarian territorial groups^{5,19,25}.

For the first time in this study, there are data for the central obesity of Bulgarian children and adolescents, assessed on the basis of the WHtR.

Our results indicate that 87.25 % of the surveyed children and adolescents of both sexes have normal fat distribution and lack central obesity (WHtR < 0.500), and those with central obesity (WHtR ≥ 0.500) are 12.75 % respectively (Table IV) independently of their nutritional status. In terms of gender comparison, 17.1 % of the boys and 9.3 % of the surveyed girls have central obesity, which is considerably less than the distribution of central obesity among children in Yemen³⁵ and slightly higher than this distribution of Pakistani children¹³.

The results we derived for the percentage of the children with different nutritional status and central obesity are very important for the clinical practice (Table V). A total of 2.7 % of all the examined children with normal weight and an average of 46.82 % of the studied obese children (overweight and obesity) have central obesity (WHtR ≥ 0.500). Our results show a lower percentage for Bulgarian children and adolescents with normal weight and central obesity (2.7 %), but a higher percentage of surveyed children with overweight and general obesity but without central obesity (53.17 %) as compared to the data for children and adolescents from Bogalusa Heath study¹¹.

A total of 14.1 % of all tested boys and girls with normal and excessive body nutritional status are with

increased health risk (WHtR \geq 0.500). With normal weight and without risk according to the IOTF BMI criteria, but with risk according to WHtR criteria (WHtR \geq 0.500) are 2.01 % of the surveyed children (Table V). Yet, this small percentage of children and adolescents must be taken seriously as they do not fall in the risk categories subject to monitoring during the screening of general obesity on the basis of BMI¹⁴.

Another important result regarding central obesity shows more frequent distribution among boys as compared to girls, which has been observed in all age periods. These data obtained by us confirm the earlier results by Mc Carthy, Aswell¹⁰ for British children, as well as the results by Mushtag et al.¹³ for Pakistani children, who also reported more frequent distribution of central obesity in males. Bamoshmoosh et al.³⁵ in their study of Yemeni children and adolescents reported a trend opposite to ours and also a predominance of girls with central obesity.

The combination of overweight or obesity with central accumulation of fat in the researched age period occurs more often among boys as compared to girls, which probably shows that ever since pre-puberty the Bulgarian boys are prone to higher cardio-metabolic risk compared to the girls, with this trend continuing into adulthood.

Conclusion

The results of this study showed that for last over one decade there has been an increase in prevalence of overweight and obesity among Bulgarian children and adolescents from Smolyan region. The disturbing fact is the relatively high percentage of underweight children, especially among in group of the girls after puberty. The greatest percentage of individuals with underweight, overweight and obesity has been observed in the period of the pre-puberty and puberty. The central obesity, as well as its combination with overweight or general obesity is more frequent in boys than in girls. This indicates confirm the greater “eco-sensitivity” and higher cardio-metabolic risk for Bulgarian boys, which starts in the period of growth.

Conflicts of interest statement

The authors declare no conflict of interest related to this manuscript.

Acknowledgements and funding

This manuscript was developed with the financial support of the Fund “Scientific Research” at Plovdiv University “ Paisii Hilendarski”, Bulgaria, Grant N° SR13 FS 007.

References

1. Dias Pitangueira JC, Rodrigues Silva L, Portela de Santana ML, Monteiro da Silva Mda C, de Farias Costa PR, D'Almeida V, de Oliveira Assis AM. Metabolic syndrome and associated factors in children and adolescents of a Brazilian municipality. *Nutr Hosp.* 2014; 29(4):865-872.
2. Nascimento-Ferreira MV, De Moraes AC, Carvalho HB, Moreno LA, Gomes Carneiro AL, Dos Reis VM, Torres-Leal FL. Prevalence of cardiovascular risk factors, the association with socioeconomic variables in adolescents from low-income region. *Nutr Hosp.* 2015; 31(1): 217-224.
3. Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. *Int J Pediatr Obes* 2006, 1:11-25.
4. Kostli RI, P. D. The epidemic of obesity in children and adolescents in the world. *Cent Eur J Pub Health* 2006, 14, 4: 151-159.
5. Mitova Z, Stoev R, Yordanova L. Nutritional Status in 9-15-years old Schoolchildren from Sofia, Bulgaria (1984-2002). *Acta Morphologica et Anthropologica* 2012, 19: 246-249.
6. Ogden C, Carroll M, Kit B, Flegal K. Prevalence of Obesity and Trends in Body Mass Index Among US Children and Adolescents, 1999-2010. *JAMA*, 2012, 307, 5:483-490.
7. World Health Organization. Noncommunicable Diseases Country Profile, 2011, 40-41.
8. Freedman D, Wang J, Maynard L, Thornton J, Mei Z, Pierson R, Dietz W, Horlick M. Relation of BMI to fat and fat-free mass among children and adolescents. *Int. J. Obes. Lond.* 2005, 29, 1:1-8.
9. Hsieh SD, Yoshinaga H, Muto T. Waist-to-height ratio, a simple and practical index for assessing central fat distribution and metabolic risk in Japanese men and women. *Int J Obes* 2003, 27: 610-616.
10. Mc Carthy HD, Ashwell M. A study of central fatness using waist-to-height ratios of UK children and adolescents over two decades supports the simple message – ‘keep your waist circumference to less than half your height’. *International Journal of Obesity* 2006, 30: 988-992.
11. Mokha J, Sathanur S, Pronabesh DM, Camilo F, Wei Ch, Jihua X, Gerald B. Utility of waist-to-height ratio in assessing the status of central obesity and related cardiometabolic risk profile among normal weight and overweight/obese children: The Bogalusa Heart Study. *BMC Pediatrics* 2010, 10:73
12. Yan W, Bingxian H, HuaY, Jianghong D, Jun C, Dongliang G, Yujian Z, Ling L, Yanying G, Kaiti X, Xiaohai F, Da D. Waist-to-Height Ratio is an Accurate and Easier Index for Evaluating Obesity in Children and Adolescents. *Obesity* 2007,15 (3): 748-752.
13. Mushtaq MU, Gull S, Abdullah HM, Shahid U, Shad MA, Akram J. Waist circumference, waist-hip ratio and waist-height ratio percentiles among central obesity among Pakistani children aged five to twelve years. *BMC Pediatr* 2011, 11:105.
14. Ashwell M, Gibson S. A proposal for a primary screening tool: ‘Keep your waist circumference to less than half your height’. *BMC Medicine* 2014, 12:207.
15. Martin R, Saller K. *Lehrbuch der Anthropologie*. Stuttgart: Gustav Fisher Verlag, 1957, 1- 661.
16. Cole T, Bellizzi M, Flegal K, Dietz W. Establishing a standard definition for child overweight and obesity worldwide: international survey. *British Medical Journal*. 2000; 320(7244):1240-1243.
17. Cole T, Flegal K, Nicholls D, Jackson A. Body mass index cut offs to define thinness in children and adolescents: international survey. *British Medical Journal*. 2007; 335(7612):194-197.
18. Mladenova S, Nikolova M. Distribution of overweight and obesity among Smolyan children and adolescents. *Proceedings with scientific reports from Jubilee National Conference with International Participation “20 years of Union of Scientists in Smolyan”*, part Biology and Medicine. Smolyan, 2006, 1025 – 1034 (In Bulgarian)
19. Nikolova M, Tineshev S. Comparison of the body mass index to other methods of body fat assessment in Bulgarian children and adolescent. *Biotechnol. & Biotechnol. EQ.* 2010. 24/SE : 329-337.

20. Nacheva A, Gecheva Y, Yankova I, Filcheva Z, Mitova Z, Yordanov Y. Physical development of children and adolescents in the borderline between XX and XXI century. *Monographs. Prof Marin Drinov Academic Publishing House* 2012, 1-417 (In Bulgarian)
21. Jehn ML, Gittelsohn J, Treuth MS, Caballero B. Prevalence of overweight among Baltimore city schoolchildren and its associations with nutrition and physical activity. *Obesity*, 2006, 14 (6): 989-993.
22. Gontarev S, Kalac R. Association between obesity and socioeconomic factors in Macedonian children and adolescents. *Advanced in Life Sciences and Health* 2014, 1 (1): 55-63.
23. Grammatikopoulou M, Poulimeneas D, Gounitsioti I, Gerothanasi K, Tsigga M, Kiranas E. Prevalence of simple and abdominal obesity in Greek adolescents: the ADONUT study. *Clinical obesity*, 2014, (4): 303-308.
24. World Health Organization. Regional Office for Europe, 2013. Nutrition, Physical Activity and Obesity. Bulgaria. //Country profiles covering developments in nutrition, physical activity and obesity in the WHO European Region. Available online at: <http://www.euro.who.int/en/nutrition-country-profiles>.
25. Mitova Z. Anthropological characteristics of physical development, body composition and body nutritional status in 9-15-years old children and adolescents from Sofia city. Sofia, Bulgaria. *Autoref. PhD thesis*, 2009 (In Bulgarian).
26. Tineshev S. Anthropological characteristics of children and adolescents. Plovdiv, Bulgaria, (In Bulgarian).
27. Pavlica T, Rakic R, Djuricanin A, Korovljevic D, Srdic B. Growth and nutritional status of children and adolescents from 7 to 19 Years of age in the town of Jagodina (Central Serbia), *HealthMed* 2012, 6 (1): 284-293.
28. Kurtulus E. Obesity: In World and Turkey. I wanna learn wicth that how often obesity to be seen in the World and Turkey. *EAA Summer School eBook* 2007 (1): 175-179.
29. He L, Ren X, Chen Y, Jin Y, Pan R, Wei N, Qiu S, Lu W, Ding L, Guo D, Wang L, Nie Z, Yao Y. Prevalence of overweight and obesity among primary school children aged 5 to 14 years in Wannan area, China. *Nutr Hosp*. 2014;30(4):776-781.
30. Ferreira Marques CD, Ribeiro Silva Rde C, Machado ME, Portela de Santana ML, Castro de Andrade Cairo R, Pinto Ede J *et al*: The prevalence of overweight and obesity in adolescents in Bahia, Brazil. *Nutr Hosp* 2013, 28(2):491-6
31. Yankova I, Zhecheva Y, Nacheva A, Yordanov Y. Underweight in Bulgarian Boys and Girls from 3 till 17 years of Age living on the Borderline between 20th and 21st century. *Acta morphologica et anthropologica* 2010, 16: 65-75.
32. Mladenova, S. Physical development and lifestyle of schoolchildren from Smolyan region (preliminary data). *Conference proceedings of International Conference "Innovations, Challenges and Tendencies in Postmodern Education"*, Stara Zagora, 2013. Available online at: <http://pf-conference.info/bg/rapports> (In Bulgarian).
33. Hills A, Andersen L, Byrne N. Physical activity and obesity in children. *British Journal of Sport Medicine* 2011, 45(11): 866-70.
34. Permyakova E. 2010. Contemporary tendencies in fat development in urban and rural children and adolescents. Scientific Research Institute and Museum of Anthropology, Moscow State University "Mihail Lomonosov", Moscow. *Autoref. PhD Thesis* 2013 (In Russian).
35. Bamoshmoosh M, Massetti L, Aklan H, Al-Karewany M, Al-Goshae H, Amedeo Modesti P. Central obesity in Yemeni children: A population based cross-sectional study. *World J Cardiol* 2013, 5(8): 295-304.