

Anthropology and Anatomy

Prevalence of Underweight and Overweight among Preschool Children from Sofia Assessed through Different International References

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The aim is to describe the frequency of categories nutritional status in Bulgarian preschool children according to different classification systems based on body mass index.

Results: The overall prevalence of overweight including obesity in boys is 7.8%, 9.3%, 12.0% according to WHO, IOTF, BG respectively. In girls, overweight including obesity varied from 9.4% (WHO), 10.6% (IOTF), and 13.4% (BG-references). The overall frequencies of moderate and severe thinness in boys are 14.2% and 2.0% (IOTF), and 12.2 % and 5,1 % (BG-reference). In girls the moderate thinness frequency is 9.10% and 7.0% assessed by IOTF and BG values respectively and girls classified as severe thin are 3.4% (IOTF) and 6.7 % (BG-reference). The total prevalence of thinness according to WHO criteria is 0.7%.

Conclusion: We found significant differences in estimated frequencies of thinness and overweight using the three selected criteria. In the absence of a global definition, we need both national and international growth references.

Key words: underweight, overweight, thinness, preschool children, body mass index, international body mass index references

Introduction

Excess body weight is the sixth most important risk factor, contributing to the overall burden of disease worldwide, with 10% of children now classified as overweight [2]. Childhood overweight, including obesity is recognised as a serious public health problem and is subject of many publications. Data about underweight (thinness), on other hand, are scarce and insufficient in the literature. Thinness also entails health

consequences: it lowers immunity, decreases the general efficiency of the system and increases the risk of chronic diseases, so it should not be neglected in surveys concerning the health status in children. The preschool age is an immensely significant period of time for the subsequent stages of life [10] and is one of the critical periods for the development of obesity [23], however, it is one of the least studied childhood periods.

The aim of the study is to describe the frequency of obesity, overweight and thinness by gender and age in 3-6-year-old Bulgarian children according to different classification systems based on Body Mass Index (BMI).

There is general consensus that studies of childhood obesity prevalence should be reported according to different international references, which makes the results comparable at international level, and should be complemented with national references or additional references such as the CDC [16, 3]. Therefore, we report the prevalence of the categories Nutritional Status (NS) according to three classification systems - the International Obesity Task Force reference (IOTF-reference), the World Health Organisation growth standard (WHO-reference) definitions and in addition we use Bulgarian reference values (BG-reference).

Materials and Methods

The study is carried out in 15 randomly selected kindergartens on the territory of Sofia - the capital of Bulgaria, throughout the period 2014-2015. The study is cross-sectional and includes 870 healthy children from 3 to 6 years of age, who attend the selected institutions. The sample includes 451 boys (51.8%) and 419 girls (48.2%) with balanced number of children in all age and sex classes (≈ 100). Anthropometric characteristics (height, weight and BMI) of the sample are presented according to gender and age in **Table 2**.

The research is performed with the approval of Bulgarian Ministry of Health and of Health department and Education department of the Sofia Municipality. Undersigned informed consent form is obtained from the parents/caregivers of participants prior the implementation of the study procedures. The study is conducted according to the Helsinki Declaration in its latest version from 2013 year.

Measurements

All anthropometric measurements are taken by a trained team according to the standardized procedures [11, 22]. Body weight is measured by body fat monitor (Tanita BF666, Japan) to the nearest 50g. Height is measured by anthropometer (GPM Antropologische Instrumente, Switzerland) to the nearest 0.5 cm. Anthropometric measurements are performed in the morning in lightly dressed children, without shoes. BMI is calculated as $\text{weight (kg)/height (m)}^2$.

Three BMI references are used in order to assess the children's NS: 1 - IOTF-reference (2000 [5], 2007 [6]); 2 - WHO - reference (2006 [21], 2007 [19]), and 3 - Bulgarian reference values. The Bulgarian reference values are gender and age specific percentile values (< P5 (severe thinness); P5-P15 (moderate thinness); > P85 (overweight); > P95 (obesity)) elaborated on the basis of a data gathered in previous representative study of 3-6 years old children conducted in Sofia (2004-2005) by the first author of the current publication (Y. Zhecheva, 2008 [25]). The percentiles are the same recommended and used by the WHO [8] and CDC [4] as a cut-off values for the assessment of different categories NS.

The BMI cut-offs used to define overweight, obesity, moderate and severe thinness according to the three classification systems are presented in **Table 1**.

Table 1. Cut-offs for BMI used to define categories nutritional status in children according to various references

Nutritional status categories	BMI-cut-offs		
	WHO	IOTF***	BG-reference
Severe thinness	< -3SD	BMI < 17 kg/m ²	< P5
Moderate thinness	< -2 SD	BMI 17 to 18.5 kg/m ²	P5-P15
Overweight	>+1 SD*	BMI 25-30 kg/m ²	> P85
Obesity	>+2SD**	BMI > 30 kg/m ²	> P95

*equivalent to BMI 25 kg/m² at 19 years; **equivalent to BMI 30 kg/m² at 19 years

***IOTF child cut-offs correspond to the cut-offs of a BMI of 17, 18.5, 25 and 30 at age 18 years

Table 1a. Bulgarian BMI cut-off values for defining thinness, overweight and obesity by sex and age

Age (years)	Severe thinness	Thinness	Overweight	Obesity
Boys				
3	< 13.75	13.75-14.44	17.05-18.34	> 18.35
4	< 13.45	13.45-14.44	17.05-18.24	> 18.25
5	< 13.95	13.95-14.34	16.85-18.04	> 18.05
6	< 13.65	13.65-14.44	17.65-20.44	> 20.45
Girls				
3	< 14.05	14.05-14.44	16.95-18.04	>18.05
4	< 13.35	13.35-14.14	17.65-18.14	> 18.15
5	< 13.75	13.75-14.04	16.35-17.94	> 17.95
6	< 13.25	13.25-13.94	18.05-19.54	> 19.55

Statistics

Statistical analysis is performed using SPSS v.16 software. Mean and standard deviation for each variable are calculated. The statistical significance between age- and gender groups is evaluated using t-test of Student. Comparisons of the frequencies between age classes or between genders are performed using tests for nonparametric comparisons - z-test and chi-square on p-level 0.05.

Results and Discussion

The present study provides information about the current NS of Bulgarian preschool children aged 3 to 6 years. The assessment of NS according to both international criteria and the Bulgarian cut-offs gives us the possibility to determine which of the internationally applied criteria gives closer results to the results estimated using BG-references.

Anthropometric characteristics (height, weight and BMI) of the sample are presented according to gender and age in **Table 2**.

Frequencies of different categories NS, estimated according to the three references, are presented in **Table 3**.

Table 2. Statistical data about investigated anthropometric features by age and sex

	Boys				Girls			
Age (years)	3	4	5	6	3	4	5	6
n	103	100	128	120	102	100	111	106
Height (cm)								
Mean	99.8*	106.7‡	113.9‡	121.5*‡	98.4	106.5‡	113.1‡	119.4‡
Std. Deviation	4.7	5.2	5.2	5.7	4.9	5.4	5.0	4.8
Minimum	89.6	95.7	101.8	106.5	84.5	93.0	101.5	106.3
Maximum	111.6	123.5	126.4	135.9	110.4	118.5	125.1	130.8
Weight (kg)								
Mean	15.8*	18.0‡	20.4‡	23.3*‡	15.1	17.7‡	20.1‡	22.4‡
Std. Deviation	1.9	3.6	3.2	4.0	2.0	2.6	3.7	3.1
Minimum	12.5	12.9	14.8	15.9	10.5	12.3	13.3	16.8
Maximum	21.3	45.2	30.5	50.4	21.4	26.4	40.0	32.2
BMI (kg/m²)								
Mean	15.8	15.7	15.6	15.7	15.6	15.6	15.6	15.6
Std. Deviation	1.2	1.9	1.5	1.7	1.2	1.4	2.0	1.6
Minimum	13.7	13.3	12.7	13.0	13.5	12.1	12.4	12.6
Maximum	21.2	29.6	20.1	27.3	19.9	20.2	25.6	19.7

*Statistical significant sexual differences, $p \leq 0.05$; ‡ Statistical significant age differences, $p \leq 0.05$

Table 3. Frequencies of obesity, overweight and thinness (moderate and severe) at different ages in girls and boys according to the WHO, IOTF and Bulgarian reference values

	Boys				Girls				Both sexes
Age (years)	3	4	5	6	3	4	5	6	3-6
n	103	100	127	120	102	99	110	106	867
	%	%	%	%	%	%	%	%	%
Overweight									
BG reference	11.7	8.0	10.2	5.0‡	13.7	1.0*	12.6	8.5‡	8.9
IOTF	7.8	8.0	10.2	5.8‡	2.9	6.0	12.6	11.3*‡	8.2
WHO	2.9	3.0	4.7	10.8	2.0	3.0	9.0	18.9	6.9
Obesity									
BG reference	2.9	4.0	5.5	0.8‡	2.0	4.0	9.9*	0.9‡	3.8
IOTF	1.0	1.0	2.3	0.8	1.0	3.0	3.6	0.9	1.7
WHO	1.0	1.0	3.1	3.3	0.0	0.0	2.7	0.9	1.6
Moderate thinness									
BG reference	12.6	19.0	6.2	12.5	7.8	9.0	1.8	9.4	9.7

Table 3 – continued

IOTF	15.5	17.0	13.4	11.7	14.7	9.1	7.3	5.7	11.8
WHO	0.0	0.0	0.8	0.8	0.0	2.0	0.9	0.9	0.7
Severe Thinness									
BG reference	1.0	1.0	10.9	5.8	8.8	5.0	9.9	2.8	5.9
IOTF	1.0	3.0	3.2	0.8	2.9	6.1	2.7	1.9	2.7
WHO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

* – Statistical significant sexual differences, $p \leq 0.05$; ‡ - Statistical significant age differences, $p \leq 0.05$

Overweight

The overall prevalence of overweight including obesity in boys is 7.8%, 9.3%, 12.0% according to WHO, IOTF, BG respectively; the obesity prevalence varied between 2.2% assessed by WHO standards, 1.3% using IOTF, and 3.3% according to BG-reference (**Fig. 1**).

In 3-6 years old girls, overweight including obesity varied from 9.4% using WHO, 10.6% using IOTF, and 13.4% according to BG-references, and obesity alone: 1.0%, 2.2%, 4.3% (WHO, IOTF, BG respectively) (**Fig. 2**).

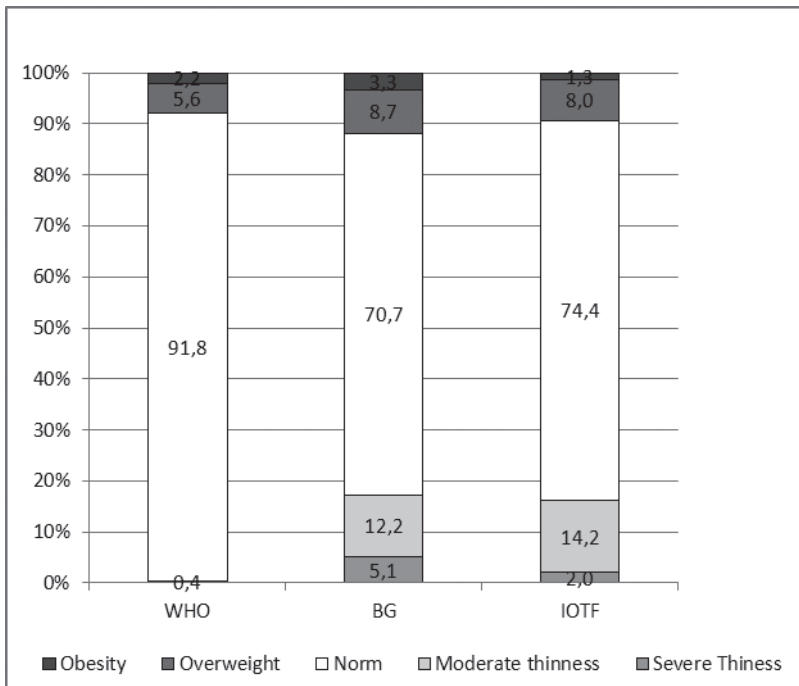


Fig. 1. Frequencies of different categories NS in 3-6 years old boys assessed on the basis of three references

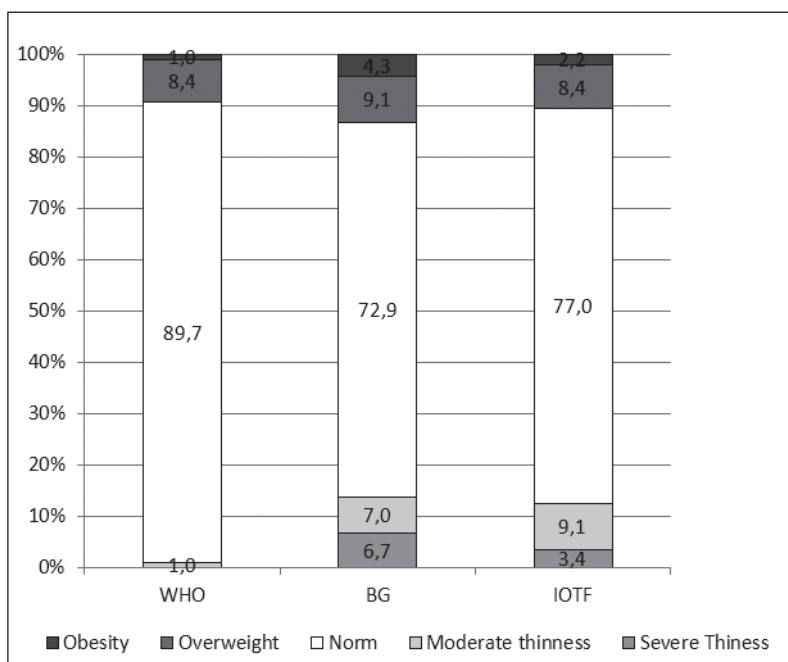


Fig. 2. Frequencies of different categories NS in 3-6 years old girls assessed on the basis of three references

As a rule, most of the studies in children and adolescents report higher estimates for overweight and obesity using WHO reference values than these of IOTF [15, 17, 3, 1]. Our results show that overall WHO generated lower overweight (including obesity) prevalence compared to IOTF criteria and both international criteria estimate lower frequencies compared to Bulgarian reference values.

The results established in 5 years old Czech girls are similar to our data; 3,4% were classified as overweight using the WHO reference values versus 15,3% using the IOTF definition. Authors explain that the result is due to the choice of cut-offs and to the different criteria used to select the sample for the IOTF-reference and that of the WHO standards for children aged 0 to 5 years (sample including individuals who were breastfed for at least 6 months and came from socioeconomics conditions that were favorable for healthy growth) [12].

The difference between estimations with the three criteria is more evident in obesity rates compared to overweight. In a study conducted in Spain, for example, the prevalence of obesity from 2 to 24 years was two to three times higher using the Spanish reference population cut-offs than using the IOTF cut-offs, while the rates of overweight were similar [18].

Whatever reference is used, the number of children classified as overweight or obese is approximately equal in both sexes and sexual differences do not reach statistical significance with some exceptions - at the age of 4 and 5 using the BG-reference and in 6 years old children using IOTF. 4 years old overweight boys are considerably more (8,0%) than the overweight girls (1,0%) at the same age. The prevalence of obesity at five years of age is significantly lower in boys than in girls. At the age of 6 IOTF classified significantly more girls in the category overweight.

Sexual dimorphism in the prevalence of overweight or obesity is not apparent during the investigated period, but overall a slightly higher prevalence in girls is observed according to IOTF and BG-references. Using the WHO, the prevalence of overweight is also higher in girls, while the obesity is more common for boys. The observed differences are consistent with previous and recent studies [23, 22, 14, 3] as more boys than girls are classified as overweight or obese according to WHO, whereas the reference values published by Cole and Lobstein [7] show a higher prevalence in girls.

Significant variation in the overweight and obesity frequencies with age are established using the three different criteria. According to the BG-reference, the frequency of overweight girls decreases and increases successively between 3 and 5 years of age, reaching its lowest value at the age of 4 (1.0%). Between 5 and 6 years of age, according to BG- and IOTF-reference, a decrease in categories “overweight” and “obesity” is observed in both sexes with statistical significance in both categories using BG-reference and only in overweight boys according to IOTF.

At the age of 6 the frequency of obese boys and girls reaches its lowest values according to BG and IOTF-references (0.8% in boys; 0.9% in girls). Using the IOTF and BG values the frequency of obesity is highest in 5 years old boys and girls. The highest value of overweight frequency assessed by IOTF is also observed at this age, but according to BG-reference overweight boys and girls are most frequent at the age of 3.

Despite the change in the prevalence of overweight and obesity with age is not consistent using these two references, the trend for decreasing frequencies of overweight (more evident in boys) and obesity (more evident in girls) at the end of investigated period is observed.

An opposite trend is shown by the WHO estimations: the frequency of boys and girls categorized as overweight at the age of 6 has doubled compared to 5 years old, but the increasing is significant only in girls (from 9.0% to 18.9%). The obesity frequency increases with age in boys, reaching its highest values at 6 years of age, while in girls the prevalence of obesity is highest at the age of 5.

Thinness

Comparing the estimates for NS categories of the three criteria, the greatest discrepancies are observed in thinness.

The overall frequencies of moderate and severe thinness *in boys* are 14.2% and 2.0% using IOTF, and 12.2 % and 5.1 % according to BG values. In 3-6 years old *girls* the moderate thinness frequency is 9.10% and 7.0% assessed by IOTF and BG values respectively and *girls* classified as severe thin are 3.4% (IOTF) and 6.7 % (BG-reference). The total prevalence of thinness is smallest according to WHO criteria – 0.7%.

The estimated frequencies of thinness (moderate and severe) using IOTF and BG references are relatively equal reaching up to 20.0% in boys (4 year olds) and 17.0-18.0% in girls (4 year olds), while according to the WHO criteria the prevalence is most often under 1.0 % in the separate age and gender groups. According to the WHO not a single boy or girl is categorized as severe thin, while according to IOTF and Bulgarian references, severe thinness is presented in all age groups with total frequencies for boys and girls of 2.7% and 5.9% according to IOTF and BG references respectively (**Table 3**).

According to our findings, it could be suggested that the prevalence of thinness in Bulgarian preschool children is underestimated when using the WHO criteria. A study of Russian preschoolers report two times lower thinness frequencies assessed by the WHO references compared to the CDC estimations. [14] The probable reason for this result could be sought again in the specificity of the sample used for elaborating the growth standards of WHO for 0-5 years old children.

Gender differences in the thinness categories are more obvious compared to the overweight categories. Significant gender differences in the frequencies assessed by the Bulgarian reference values are observed: at the age of 3 - girls categorized as severe thin (8.8%) are considerably more than boys (1.0%); at 4 and 5 years of age the moderate thinness frequency is much higher in boys. Categorised by IOTF, 4 and 6 years old boys with moderate thinness are significantly more than girls. Compared to BG-reference, the values recommended by IOTF determine higher frequency of moderate thinness and lower frequency of severe thinness.

As being established in other studies, the moderate thinness occurs more often than severe thinness in both sexes [24] with predominance of boys with moderate thinness, while severe thinness is more common among girls [13]. According to WHO criteria, moderate thinness is more frequent in girls.

The thinness frequencies differ significantly with age only by using BG-reference values. The variations are not consistent but are similar in both sexes - decreasing of the frequency of moderate thinness between 4 and 5 years of age (from 19.0 to 6.2% - boys ($p \leq 0.05$)); from 9 to 1.8% - girls ($p \leq 0.05$)) accompanied with increasing in severe thinness (from 1.0 to 10.9% - boys; from 5.0 to 9.9% - girls). During the following age period the changes are opposite - severe thinness decreasing (significantly only in girls) and moderate thinness increasing significantly in both sexes. Using IOTF reference values the thinness is more common among 3 and 4 years old boys and girls and decreases insignificantly with age, more pronounced in girls. Both criteria show a decreasing trend in thinness with age more pronounced in girls, and more evident when using IOTF references. Our results are consistent with a study in children and adolescents in Netherlands where it is established that thinness is occurring most often in children aged 2-5 years. [9]

At the age of 6, as a result of decreasing frequencies of the unhealthy weight categories – overweight, obesity and underweight, the percentage of boys and girls with healthy NS is highest using the IOTF and BG criteria. In contrast, according to the WHO reference values, the relative share of boys and girls with healthy NS decreasing successively with age.

Conclusions

We found significant differences in estimated frequencies of thinness and overweight using the three selected criteria, two international and one Bulgarian.

Based on the results of the current study we could conclude that compared to WHO standards, the results of the frequency of different categories NS estimated by IOTF-references are closer to these estimated by BG-references. Therefore we consider that for international comparisons the cut-offs of Cole are more appropriate for use. For the identifying of population groups with higher health risk concerning NS and for planning preventive care services and evaluating the impact of policy initiatives on national and regional level the use of national references is more appropriate and relevant.

In the absence of a global definition, we need both national and international growth references.

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