

## ORIGINAL SCIENTIFIC PAPER

# Prevalence of Overweight and Obesity of Preschool Children in Vranje (Serbia) According to the WHO and CDC Recommendations

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## Abstract

Overweight and obesity are widespread worldwide among children of all age groups, and the prevalence among preschool children has been steadily increasing over the past twenty years. The aim of this study was to determine the prevalence of overweight and obesity of preschool children in Serbia based on the recommendations given by the WHO (World Health Organization) and the CDC (Centers for Disease Control and Prevention). The sample of respondents consisted of children from the preschool institution "Our Child" (serb. Naše dete) from Vranje, Serbia. A total of 380 children participated, of which 195 were boys (51.3%) and 185 were girls (48.7%). The age of the child ranged from 2 to 7 years, that is, from 26 to 84 months. In order to determine the weight status, the children's body weight and height were measured, on the basis of which the Body Mass Index (BMI) was calculated. The obtained BMI values were interpreted based on the recommendations given by the WHO and the recommendations given by the CDC. Research results based on the WHO recommendations showed that 11.1% of the total number of children are overweight and 11.8% are obese, while based on the CDC recommendations, 11.8% of the total number of children are overweight and 7.9% are obese. Also, the research showed that there is no difference in the weight status categories between boys and girls. However, the results show that the proportions of overweight and obese children obtained using the WHO recommendations differ significantly from the proportions of overweight and obese children obtained using the CDC recommendations. High percentages of overweight and obesity among preschool children in Vranje require adequate measures to be taken in order to stop and reduce their growth.

**Keywords:** preschoolers, weight status, BMI status, obese children, different recommendations

## Introduction

Overweight and obesity refer to an excessive accumulation of fat that may pose a risk to health (Ilić, 2014). Childhood obesity is a major global public health issue, leading to significant and long-lasting health complications (Liu et al., 2022; Mantzorou et al., 2023). The consequences are in the form of physical and mental health disorders, increased risk of diabetes, cardiovascular diseases, osteoarticular diseases and cancer (Liu et al., 2022). Obesity affects a child's development, often persisting into adulthood and increasing the risk of psychosocial issues, cardiovascular diseases, and cancer (Fäldt et al., 2023).

Overweight and obesity are prevalent worldwide in children of all age groups (Woronko et al., 2023). According to the latest World Health Organization (WHO) reports, it is estimated that 41 million children under the age of five are affected by overweight or obesity (Wang et al., 2022). Nikolić, Gažić and Stamenković (2022) analyzed 46 studies and determined that the prevalence of overweight and obese preschool children is high on all continents, that it is the highest in North America, that Europe is not far behind them. However, some studies from Asia and Africa indicate that children in Africa have not yet reached the same prevalence of overweight and obesity as their peers in



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North America and Europe. Over the last 30 - 40 years, the prevalence has been steadily increasing and is expected to continue to increase in the coming decades (Miguel-Berges et al., 2023). Between 1980 and 2013, the prevalence of obesity among children and adolescents in developing countries rose from 8% to 13% for both boys and girls. In Africa, the prevalence of obesity in preschool children increased from 4% in 1990 to 8.5% in 2010 (Gebremedhin, 2015). Đurašković et al. (2012) found that the overall prevalence of overweight and obesity in 7-year-old children from Nis (Serbia) increased from 10.63% to 42.05% in the period from 1988 to 2008. Sekhobo et al. (2010) found that the overall prevalence of overweight and obesity in children aged 2 to 5 years from New York (USA) increased from 25.5% to 32.1% between 2002 and 2007. Vuceraković and Mitrović (2021) determined that the overall prevalence of overweight and obesity in children aged 5 to 6 from Podgorica (Montenegro) increased from 33.33% to 45.65% in the period from 2013 to 2020. A national survey conducted in 9 cities in China revealed an increase in the prevalence of overweight and obesity in children from 11.7% to 25.2% between 1991 and 2011 (Wang et al., 2022).

Authors from our region found that children from Serbia are not behind children from Europe in the prevalence of overweight and obesity (Đurašković et al., 2012; Cvetković & Cvetković, 2018; Ilić, 2014; Jovanović et al., 2010; Međedović et al., 2014; Pelemiš et al., 2021; Peulić, Katanic, Jovanović, & Bjelica, 2024; Stupar, Popović & Vujović, 2014). Therefore, childhood obesity is currently viewed as one of the most prevalent public health problems in our country (Kisić-Tepavčević et al., 2008). For these reasons, there is a need to monitor the physical development of children, and one of the most reliable methods for tracking children's weight status is through anthropometric measurements, specifically by calculating the Body Mass Index (BMI).

It should be noted that BMI in adults and children is calculated using the same formula, but the interpretation of the obtained values is not the same because the amount of fat in the body changes with age. Also, the amount of fat in boys and girls is different. Some previous studies support this and show that the prevalence of obesity among preschool children varies depending on whether WHO or CDC (Centers for Disease Control and Prevention) recommendations were used (Al Alawi et al., 2013; Kułaga et al., 2016; Ma et al., 2011; Twells & Newhook, 2011).

Although some international studies have shown that there may be differences in the level of obesity among children depending on the different WHO and CDC cut-off values, there are still no such studies involving our children. In this context, the aim of this paper was to determine the prevalence of overweight and obesity of preschool children in Serbia based on the recommendations given by the WHO and the CDC.

## Methods

### Participants

The sample of respondents in this research consisted of children from the preschool institution "Our Child" (serb. Naše dete) from Vranje, Serbia. A total of 380 children participated, of which 195 were boys (51.3%) and 185 were girls (48.7%).

The criteria for including and selecting subjects were as follows: healthy children (those without any diseases or disorders) of both genders, aged 2 to 7 years, from preschool institution. Therefore the child's age ranged from 2 to 7 years, that is, from 26 to 84 months, and the average age was 4.42 years, that is, 58.63 months. Parental consent was obtained for each child who participated in the research. The research process adhered to the principles outlined in the Helsinki Declaration (World Medical Association, 2011), and the study was approved by the Faculty of Sport and Physical Education from Nis (Ethics Committee).

### Measurements

In order to determine the weight status, the children's body weight and height were measured, on the basis of which the Body Mass Index (BMI) was calculated. Body height was measured with an anthropometer (GPM, Zurich, Switzerland) with the subject standing on a horizontal flat surface in an upright position with the back extended and the heels together. The lower side of the arm of the anthropometer is placed on the most prominent part of the crown of the head (vertex). The result of the measurement was read with an accuracy of 0.1 cm, and then they were converted into meters. Body mass was measured with an electronic Tefal 6010 scale (Rumilly, Haute-Savoie, France) in subjects who, minimally dressed, stood calmly on the landing shaft of the scale in an upright position. The measurement result was read from the scale screen with an accuracy of 0.1 kg. BMI was calculated according to the standard formula, i.e.  $BMI = BM(kg)/BH(m)^2$ .

The obtained BMI values were interpreted based on the recommendations given by the WHO and CDC. These recommendations take into account the gender and age of the child and convert the BMI values into percentiles on the basis of which the position of a certain index value is determined in relation to a group of children of the same gender and age. Therefore, children were classified into four distinct weight categories: underweight, normal weight, overweight, and obese (Table 1).

In order to determine the position of the BMI value, the children's calendar age was taken from the records in the preschool institution, for which there was parental consent. Tables and graphs by which children were categorized according to the level of weight are available on the WHO website (WHO, 2024) and the CDC website (CDC, 2024).

### Statistics

Data processing was performed with the SPSS 20 statistics software (SPSS Inc., Chicago, IL, USA). The basic parameters of descriptive statistics were calculated, including the arithmetic mean, standard deviation, frequencies, and percentages. The following was used: Chi-square ( $\chi^2$ ) test of independence to determine the association between the weight status and gender of children; the association between the weight status and the choice of the WHO or CDC recommendations. According to Cohen's (1988) criterion from 0.01 to 0.29 is a small association (effect), from 0.3 to 0.49 is a medium association (effect) and for 0.50 is a large association (effect) (Pallant, 2011). For all statistical analyses, significance was accepted at  $p < 0.05$ .

**Table 1.** Weight status categories

Underweight	Less than 5th percentile	<5th percentile
Normal weight	From the 5th to less than the 85th percentile	5-85th percentile
Overweight	From the 85th to less than the 95th percentile	85-95 percentile
Obesity	Equal to or greater than the 95th percentile	≥95th percentile

**Results**

Table 2 presents the descriptive parameters of the analyzed variables, revealing that 70.5% of children were of normal weight, with minor gender differences. The table also shows

that the percentage of children with normal weight varied from year to year, without a clear linear trend of increase or decrease. When the variables of body height and body weight were analyzed, both exhibited a linear growth trend with age.

**Table 2.** Descriptive parameters of the sample of respondents and weight status based on two different classifications

Age	Sex (N)	Height (M±SD)	Weight (M±SD)	BMI (M±SD)	WHO			CDC				
					UW (N/%)	NW (N/%)	OW (N/%)	O (N/%)	UW (N/%)	NW (N/%)	OW (N/%)	O (N/%)
2-3	M (16)	(95.2±3.47)	(14.98±1.89)	(16.52±1.74)	/	(12/75%)	(1/6.3%)	(3/18.8%)	(2/10.5%)	(14/73.7%)	(3/15.8%)	/
	F (19)	(94.2±5.57)	(14.03±1.63)	(15.82±1.52)	(1/5.3%)	(14/73.7%)	(3/15.8%)	(1/5.3%)	(2/10.5%)	(14/73.7%)	(3/15.8%)	/
	T (35)	(94.66±4.69)	(14.46±1.79)	(16.14±1.63)	(1/2.9%)	(26/74.3%)	(4/11.4%)	(4/11.4%)	(2/5.7%)	(27/77.1%)	(3/8.6%)	(3/8.6%)
3-4	M (48)	(101.31±6.61)	(16.58±2.67)	(16.08±1.32)	(2/4.2%)	(31/64.6%)	(7/14.6%)	(8/16.7%)	(3/6.3%)	(34/70.8%)	(7/14.6%)	(4/8.3%)
	F (36)	(101.16±5.6)	(16.53±2.6)	(16.18±2.52)	(3/8.3%)	(22/61.1%)	(5/13.9%)	(6/16.7%)	(4/11.1%)	(21/58.3%)	(6/16.7%)	(5/13.9%)
	T (84)	(101.24±6.16)	(16.56±2.63)	(16.13±1.92)	(5/6%)	(53/63.1%)	(12/14.3%)	(14/16.7%)	(7/8.3%)	(55/65.5%)	(13/15.5%)	(9/10.7%)
4-5	M (31)	(110.11±4.15)	(18.96±2.7)	(15.58±1.41)	(2/6.5%)	(21/67.7%)	(6/19.4%)	(2/6.5%)	(4/12.9%)	(22/71%)	(3/9.7%)	(2/6.5%)
	F (37)	(110.69±5.59)	(18.91±2.79)	(15.4±1.64)	(1/2.7%)	(27/73%)	(6/16.2%)	(3/8.1%)	(5/13.5%)	(23/62.2%)	(6/16.2%)	(3/8.1%)
	T (68)	(110.43±4.96)	(18.93±2.73)	(15.48±1.53)	(3/4.4%)	(48/70.6%)	(12/17.6%)	(5/7.4%)	(9/13.2%)	(45/66.2%)	(9/13.2%)	(5/7.4%)
5-6	M (57)	(116.91±4.85)	(21.15±2.92)	(15.43±1.53)	(5/8.8%)	(44/77.2%)	(4/7%)	(4/7%)	(8/14%)	(43/75.4%)	(3/5.3%)	(3/5.3%)
	F (48)	(115.84±6.22)	(21.45±3.31)	(15.96±2.01)	(1/2.1%)	(37/77.1%)	(2/4.2%)	(8/16.7%)	(2/4.2%)	(36/75%)	(7/14.6%)	(3/6.3%)
	T (105)	(116.42±5.52)	(21.29±3.09)	(15.67±1.78)	(6/5.7%)	(81/77.1%)	(6/5.7%)	(12/11.4%)	(10/9.5%)	(79/75.2%)	(10/9.5%)	(6/5.7%)
6-7	M (43)	(123.82±4.61)	(24.19±4.52)	(15.69±2.15)	(2/4.7%)	(31/72.1%)	(3/7%)	(7/16.3%)	(6/14%)	(28/65.1%)	(4/9.3%)	(5/11.6%)
	F (45)	(123.13±5.0)	(22.94±3.99)	(15.07±2.15)	(8/17.8%)	(29/64.4%)	(5/11.1%)	(3/6.7%)	(12/26.7%)	(25/55.6%)	(6/13.3%)	(2/4.4%)
	T (88)	(123.47±4.8)	(23.55±4.28)	(15.37±2.16)	(10/11.4%)	(60/68.2%)	(8/9.1%)	(10/11.4%)	(18/20.5%)	(53/60.2%)	(10/11.4%)	(7/8%)
SM (195/51.3%)	(111.73±10.75)	(19.84±4.4)	(15.76±1.66)	(11/5.6%)	(139/71.3%)	(21/10.8%)	(24/12.3%)	(21/10.8%)	(21/10.8%)	(140/71.8%)	(17/8.7%)	(17/8.7%)
SF (185/48.7%)	(111.5±11)	(19.58±4.29)	(15.66±2.07)	(14/7.6%)	(129/69.7%)	(21/11.4%)	(21/11.4%)	(25/13.5%)	(25/13.5%)	(119/64.3%)	(28/15.1%)	(13/7%)
SS (380/100%)	(111.62±10.86)	(19.72±4.35)	(15.71±1.87)	(25/6.6%)	(268/70.5%)	(42/11.1%)	(45/11.8%)	(46/12.1%)	(46/12.1%)	(259/68.2%)	(45/11.8%)	(30/7.9%)

Legend: N-number; M- male; F-female; M±SD-mean ± standard deviation; BMI-body mass index; UW-underweight; NW-normal weight; OW-overweight; O-obese; WHO-world health organization; CDC-US centers for disease control and prevention; SM-sum of male; SF-sum of female; SS-sum of all subjects; T-total.

The results of the research based on WHO recommendations showed that, out of the total number of children, 6.6% were underweight, 70.5% were of normal weight, 11.1% were overweight, and 11.8% were obese (Table 3). To gain a clearer understanding of the weight issue, it was determined that 70.5% of preschool children were of normal weight, while

29.5% had some weight-related problems. According to CDC recommendations, 12.1% of the children were underweight, 68.2% were of normal weight, 11.8% were overweight, and 7.9% were obese. Thus, 68.2% of children were of normal weight, and 31.8% had some weight-related problems.

The X<sup>2</sup> test of independence did not show a significant

**Table 3.** Weight status of preschool children in Vranje

Weight status	WHO		CDC	
	N	%	N	%
Underweight	25	6.6%	46	12.1%
Normal weight	268	70.5%	259	68.2%
Overweight	42	11.1%	45	11.8%
Obesity	45	11.8%	30	7.9%
Children who are normally weight	268	70.5%	259	68.2%
Children who are not normally weight	112	29.5%	121	31.8%

Legend: N - number of respondents; % - percentage of respondents; WHO - results according to the recommendations of the World Health Organization; CDC - results according to the recommendations of the Center for Disease Control and Prevention.

association between gender and weight status both according to the WHO recommendations ( $X^2(n=380)=0.670$ ,  $p=0.880$ , Cramer's  $V=0.042$ ) and according to the CDC recommendations ( $X^2(n=380)=5.013$ ,  $p=0.171$ , Cramer's  $V=0.115$ ) (Table 4). This means that the proportions of boys in all four weight

status categories do not differ significantly from the proportions of girls in those same categories. There is no connection between gender and weight status. More precisely, the prevalence of underweight, normal weight, overweight and obesity is the same in boys and girls.

**Table 4.** X<sup>2</sup> test of independence of the association between gender and weight level

		WHO				X <sup>2</sup>	P	Cramer's V
Gender		Underweight	Normal weight	Overweight	Obesity			
Boys		11 (5.6%)	139 (71.3%)	21 (10.8%)	24 (12.3%)	0.670	0.880	0.042
Girls		14 (7.6%)	129 (69.7%)	21 (11.4%)	21 (11.4%)			

  

		CDC				X <sup>2</sup>	P	Cramer's V
Gender		Underweight	Normal weight	Overweight	Obesity			
Boys		21 (10.8%)	140 (71.8%)	17(8.7%)	17 (8.7%)	5.013	0.171	0.115
Girls		25 (13.5%)	119 (64.3%)	28 (15.1%)	13 (7.0%)			

Legend: WHO - results according to the recommendations of the World Health Organization; CDC - results according to the recommendations of the Center for Disease Control and Prevention; X<sup>2</sup> - test result; p - significance level; Cramer's V - effect size.

The X<sup>2</sup> test of independence showed a significant association between weight status and the recommendation used to define it ( $X^2(n=760)=9.468$ ,  $p=0.024$ , Cramer's  $V=0.112$ ). This indicates that the proportions of children in all four weight status categories based on WHO recommendations differ significantly from those based on CDC recommendations. Specifically, the proportions of underweight, normal weight, overweight, and obese children are not the same when using WHO versus CDC criteria. The prevalence of underweight children is 6.6% according to WHO cut-off values, near-

ly double under CDC guidelines at 12.1%. The difference in normal weight children is smaller, with 70.5% under WHO and 68.2% under CDC. The smallest discrepancy is for overweight children, with 11.1% under WHO and 11.8% under CDC. However, there is a substantial difference in obesity prevalence, with 11.8% under WHO and 7.9% under CDC guidelines. Based on the Cramer's V coefficient, the differences between the proportions of children classified as underweight, normal weight, overweight, or obese by WHO and CDC standards are considered small.

**Table 5.** X<sup>2</sup> test of independence - association of weight level with the choice of the WHO or CDC recommendation

Org.	Underweight	Normal weight	Overweight	Obesity	X <sup>2</sup>	P	Cramer's V
WHO	25 (6.6%)	268 (70.5%)	42 (11.1%)	45 (11.8%)	9.468	0.024	0.112
CDC	46 (12.1%)	259 (68.2%)	45 (11.8%)	30 (7.9%)			

Legend: Org. - organization; WHO - results according to the recommendations of the World Health Organization; CDC - results according to the recommendations of the Center for Disease Control and Prevention; X<sup>2</sup> - test result; p - significance level; Cramer's V - effect size.

**Discussion**

The results of our research indicate that the prevalence of overweight and obese children in Vranje is high, regardless of

the criteria used to define weight status. According to the results obtained based on the WHO recommendations, as many as 22.9% of children are overweight/obese, while based on the



CDC recommendations, that percentage is 19.7%. The results require adequate measures to be taken in order to reduce the mentioned percentages and save children from the consequences that the state of overweight and obesity can cause.

#### *Overnutrition and obesity according to the WHO recommendation*

The percentage of overweight children in our research was 11.1% and 11.8% of obese children. Jovanović et al. (2010) obtained similar results on a sample of 193 children aged 4 and 5 from Pančevo and determined that 13.5% of children were overweight and 15% were obese. Đurašković et al. (2012) obtained even more alarming data. Their research shows that the percentage of overweight and obese children is higher than in our and the previously mentioned research. Based on a sample of 176 children aged 7 years from Niš, the authors determined that 25.6% of children were overweight and 16.5% were obese. Also, Ilić (2014) determined on a sample of 1051 preschool children from Jagodina and Čuprija that 19.5% of children were overweight and 14.6% were obese. The above shows that the children in our research are slightly less overweight/obese compared to the aforementioned research from Serbia.

However, if we compare our research with the research of Kułaga et al. (2016) we can see that our children from Serbia are more obese than their peers from Poland. The authors, based on a sample of 5026 children aged 2 to 6 years, determined that 11.1% of children are overweight, which is the same as in Vranje, but that only 4.1% of children are obese, which is far less than in Vranje where obesity is 11.8%. It is similar to the data from Madrid obtained by Ortiz-Marrón et al. (2018). On a sample of 2,435 children aged 4 to 6 years, the authors determined that the prevalence of overweight children was 16.5%, which is higher than in Vranje, but that the prevalence of obesity was 5.5%, which is far less than among our children.

According to the research by Ma et al. (2011) children in Northeast China have a similar prevalence of overweight and obesity as children in Serbia. In a sample of 8,653 children aged 2 to 7 years, the authors determined that 10.9% were overweight and 13.8% were obese. Children from Santiago (Chile) have a far higher prevalence of overweight and obesity compared to our and other studies, and this was determined by Kain et al. (2009). Based on a sample of 1089 children aged 5 years, the authors found that 26.6% of children were overweight and 15.6% were obese. That the situation is not better even in Canada is confirmed by Twells and Newhook (2011) who, based on a sample of 1026 preschool children, found that 26% were overweight, which is far more than in Vranje, and that 11.3% were obese, which is approximately as in our research.

According to a study by Gebremedhin (2015) conducted on a sample of 155726 children aged 0 to 5 years in Sub-Saharan Africa, the prevalence of overweight/obese children is far lower than in our study and other mentioned studies. 3.9% of children were overweight and 2.9% were obese. Similar data comes from South India. Kumar et al. (2008) found on a sample of 425 children aged 2 to 5 years that 4.47% of children were overweight and 1.41% were obese, which is far less than our children. Al Alawi et al. (2013) on a sample of 387 children aged 0 to 5 years found that in the Kingdom of Bahrain, the percentage of overweight children is similar to that in Serbia and amounts to 12.1%, and the percentage of obese children is much lower and amounts to 2.6%.

#### *Overnutrition and obesity according to the CDC recommendations*

The prevalence of overweight/obesity obtained based on the CDC recommendations is not the same as when using the WHO recommendations. Therefore, the discussion of the obtained results must be done separately. Our research showed that 11.8% of children are overweight and 7.8% are obese. Similar results were obtained by Stupar, Popović & Vujović (2014) on a sample of 206 children aged 6 and 7 years from Novi Sad. The authors found that 12% of children are overweight and 9% are obese. Pelemiš et al. (2021) on a sample of 188 children aged 6 years from Belgrade determined that 9.6% of children were overweight and 7.5% were obese, which is also a similar prevalence as in our research. Somewhat different data comes from Mladenovac. Cvetković & Cvetković (2018) found on a sample of 50 children aged 6 and 7 years that overweight is 6%, which is less than in our research, but that obesity is a surprising 22%. However, the number of respondents in the aforementioned research is small, which may be the reason for different results. According to the data obtained by Đermanović, Miletić & Pavlović (2015) on a sample of 60 children, aged 5 and 6 years, the prevalence of overweight/obesity is higher in the West of Republika Srpska than in Vranje and the mentioned cities in Serbia. The authors determined that 16.7% of children were overweight and 13.3% were obese. The number of respondents in this research is also smaller, so the mentioned data should be viewed with caution.

A rather higher percentage of overweight (16.3%) and obese (15.7%) children compared to our research was found by Manios et al. (2007) on a sample of 2374 children aged 1 to 5 years from Greece. Kułaga et al. (2016) based on a sample of 5026 children aged 2 to 6 years from Poland found that 18.2% of children are overweight, which is much more than in our study, and 8.3% are obese, which is almost the same as in Vranje. Similar results were obtained by Merkiel & Chalcarz (2016) on a sample of 128 children aged 4 to 6 years, also from Poland. Overweight of children was 18.5% and obesity was 5.5%.

Based on the results obtained by Ma et al. (2011) we conclude that children from Northeast China are not behind their peers from Vranje, Serbia and Europe. Based on a sample of 8653 children aged 2 to 7 years, the authors determined that 11.3% of children were overweight and 11.7% were obese.

Nevertheless, although preschool children from Vranje have a pronounced prevalence of overweight and obesity, based on the research conducted by Willows, Johnson & Ball (2007), we see that children in Canada in 2007 had much higher percentages of the mentioned phenomena. In a sample of 1044 children aged 5 years, the authors determined that 27.5% were overweight and 37.4% were obese. Somewhat lower, but still worrying percentages of overweight/obesity of children from Canada were determined by Twells & Newhook (2011) on a sample of 1026 children of preschool age. Overweight of children was represented by 19.1%, and obesity by 16.6%.

The situation is not better in the USA where Lim et al. (2009) based on a sample of 365 children aged 3 to 5 years found that 12.9% of children were overweight and 10.3% were obese. These percentages are similar to those in our research. Sekhobo et al. (2010) arrive at somewhat higher percentages and, based on a sample of 198633 children from New York, aged 2 to 5 years, found that 17.4% were overweight and 14.7% were obese.

Based on the data obtained by Al Alawi et al. (2013) we conclude that the prevalence of overweight/obesity is slightly lower in the Kingdom of Bahrain than in Vranje. The authors, based on a sample of 387 children aged 0 to 5 years, found that 9.8% of children were overweight and 5.2% were obese.

Several studies from the east show that the prevalence of overweight there is similar to that in Vranje, but that obesity is lower. Fatemeh et al. (2012) found on a sample of 500 children aged 2 to 5 years from Birjand (Iran) that 10.6% of children were overweight and 7.6% were obese. Similar results also come from Tehran (Iran), where Gaeini et al. (2011) on a sample of 755 children aged 3 to 6 found that 10.1% of children were overweight and 4.6% were obese, as well as from Basra (Iraq) where Ali Musa & Hassan (2010) on the sample of 550 children aged 0 to 5 years found that 10.5% of children were overweight and 3.3% were obese. A few years later, data came from Iran that overweight was somewhat lower compared to the aforementioned research, and obesity was similar. Namely, Hassanzadeh-Rostami, Kavosi & Nasihatkon (2016) found that 5.7% were overweight and 5.2% obese on a sample of 8821 children aged 2 to 6 years.

#### *Differences in the level of weight between boys and girls*

The results of our research showed that there is no statistically significant difference in the prevalence of overweight and obesity between boys and girls, both according to the WHO and CDC recommendations. This means that the proportion of overweight and obese boys is not significantly different from the proportion of overweight and obese girls. However, although there is no significant difference, we should pay attention to the results we obtained following the CDC guidelines, where the percentage of overweight boys is 8.7%, and girls 15.1%, which is almost twice as much. We should repeat this research and use some other statistical analysis or a different procedure to determine if there really is a significant difference.

In contrast to the results we obtained following the WHO guidelines for determining the weight level, Kain et al. (2009) found that Chilean boys were more obese than girls (18.6% vs. 12.6%), but that the percentages of overweight were similar (25.8% vs. 25.5%). Similar data were obtained by Ma et al. (2011) who found that boys from Northeast China are more obese than girls (16.1% vs. 11.3%), while the percentages of overweight are similar (10.3% vs. 11.6%). In Canada, Twells & Newhook (2011) found that the percentage of overweight boys was higher than that of girls (28.5% vs. 23.3%), while the percentages of obesity were similar (11.7% vs. 10.8%). According to research by Đurašković et al. (2012) in Serbia, the percentage of overweight girls is higher than that of boys (28.2% versus 23.1%), while the percentage of obesity is higher among boys than among girls (17.6% versus 15.3%). Ilić (2014) states that in Serbia the percentage of overweight boys is higher than that of girls (21.8% vs. 16.9%), and that boys are more obese than girls (16.3% vs. 12.6%). Kułaga et al. (2016) found that the percentage of overweight boys in Poland is 12.2%, and girls 10%, while the percentage of obese boys is 4.9% and girls 3.4%. Based on the research of Ortiz-Marrón et al. (2018) we can see that in Madrid there is no big difference in overweight of boys (16.8%) and girls (16.2%), nor is there a big difference in obesity between boys (5.4%) and girls (5.5%).

Following the CDC guidelines for determining weight levels, the authors also came to different results. Willows, Johnson & Ball (2007) in Canada found that girls have higher percent-

ages of overweight than boys (31.2% vs. 23.8%), which is similar to our study, but that boys are more obese than girls (40.5% against 34.2%). Pelemiš, Mandić, Momčilović, Momčilović & Srdić (2021) in Belgrade found that boys have higher percentages of overweight than girls (12.1% vs. 6.1%), which is different from our and the previous research, while the percentages of obesity are similar (7.5% in boys and 7.4% in girls). Similar data were obtained by Stupar, Popović & Vujović (2014) in Novi Sad and they found that the percentage of overweight boys is higher than the percentage of overweight girls (13.5% vs. 7.6%), while the percentages of obesity are similar (8.6% in boys and 9.7% in girls). Đermanović, Miletić & Pavlović (2015) in Republika Srpska obtained similar data as the previous two groups of authors and found that the percentage of overweight boys is higher than the percentage of overweight girls (18.8% vs. 14.3%), while girls had some higher percentage of obesity than boys (14.3% vs. 12.5%). In contrast to the aforementioned research, Manios et al. (2007) in Greece, Sekhobo et al. (2010) in the USA, Gaeini et al. (2011) in Tehran, Twells & Newhook (2011) in Canada, Fatemeh et al. (2012) in Iran, Kułaga et al. (2016) in Poland and Ma et al. (2011) in Northeast China obtained percentages of overweight and obesity of preschool children that do not differ much between boys and girls.

#### *Differences in weight levels depending on the use of the CDC and WHO recommendations*

Results of our research showed that there is a statistically significant relationship between the level of weight and the recommendation that is chosen to define that level. This means that the proportions of overweight and obese children obtained using the WHO recommendations differ significantly from the proportions of overweight and obese children obtained using the CDC recommendations.

The research shows that the prevalence of overweight is higher according to the CDC (11.8%) than according to the WHO (11.1%) recommendations, while the prevalence of obesity is higher according to the WHO (11.8%) than according to the CDC (7.9%) recommendations. Similar results were obtained by Ma et al. (2011) and determined that the prevalence of overweight of preschool children is higher when using the CDC recommendations (11.3%) than when using the WHO recommendations (10.9%), while the prevalence of obesity is higher when using the WHO recommendations (13.8%) than when using the CDC recommendations (11.7%). However, Twells & Newhook (2011) found that the prevalence of overweight is higher according to the WHO (26%) than according to the CDC recommendations (19.1%), while the prevalence of obesity is higher according to the CDC (16.6%) than according to the WHO recommendations (11.3%). Similar results were obtained by Al Alawi et al. (2013) and they found that the prevalence of overweight is higher according to the WHO (12.1%) than according to the CDC recommendations (9.8%), while the prevalence of obesity is higher according to the CDC (5.2%) than according to the WHO recommendations (2.6%). On the other hand, Kułaga et al. (2016) found that the prevalence of overweight and obesity was higher according to the CDC (18.2% and 8.3%) than according to the WHO recommendations (11.1% and 4.1%).

Research results have shown that the prevalence of obese children in Vranje is high. It is considered that the main contributing factors to obesity are a sedentary lifestyle, lack of physical activity, and improper diet (Mendonça & Anjos,

2004; Planinšec & Matejek, 2004). In response to these challenges, leading health institutions, including the WHO, have developed global strategies for promoting healthy diets and physical activities, which each country should adapt to its specific conditions (Katanic et al., 2023).

This study significantly contributes to a better understanding of the issue of childhood obesity in the country. The results of this study particularly emphasize the importance of regular monitoring of anthropometric parameters and the weight status of preschool-aged children. This monitoring is crucial for the timely diagnosis and prevention of obesity, as well as for reducing the associated health risks. Based on the findings, it is possible to identify children with excess weight and refer them to appropriate treatments, making a significant step towards improving public health measures in the fight against childhood obesity.

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#### Conflicts of interest

The authors declare that there are no conflict of interest.

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## Conclusion

The results of the research showed that the prevalence of overweight and obese children in Vranje is high, regardless of whether the WHO or CDC recommendations were used when defining the level of weight. Preschool children from Vranje do not lag behind their peers from Western Europe in terms of overweight and obesity. Also, the research showed that there is no difference in the level of weight between boys and girls, that is, that boys and girls are equally overweight and obese. However, the results also show that the proportions of overweight and obese children obtained using the WHO recommendations differ significantly from the proportions of overweight and obese children obtained using the CDC recommendations. Certainly, high percentages of overweight and obesity of preschool children in Vranje require adequate measures to be taken in order to stop and reduce their growth.

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