ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

Prevalence of and contributing factors to overweight and obesity among schoolchildren of Podgorica, Montenegro

Marina Jakšić1, Milica Martinović2, Goran Belojević3, Nebojša Kavarić4, Bogdan Ašanin5, Mira Samardžić6, Snežana Pantović7, Jelena Boljević1

1Clinical Center of Montenegro, Center for Laboratory Diagnostics, Podgorica, Montenegro;
2University of Montenegro, Medical Faculty, Department of Pathophysiology and Laboratory Medicine, Podgorica, Montenegro;
3University of Belgrade, School of Medicine, Institute of Hygiene and Medical Ecology, Belgrade, Serbia;
4Public Health Center, Podgorica, Montenegro;
5University of Montenegro, Medical Faculty, Neurosurgery Clinic, Podgorica, Montenegro;
6Clinical Centre of Montenegro, Institute for Children’s Diseases, Podgorica, Montenegro;
7University of Montenegro, Medical Faculty, Department of Biochemistry, Podgorica, Montenegro

SUMMARY
Introduction/Objective Childhood obesity is an emerging public health problem. The national prevalence of child overweight/obesity in Montenegro has increased by one third in the last decade. As the overwhelming majority of Montenegrin population is urban, investigation of obesity and correlates among urban children is of special public health interest. The aim of this study was to investigate the prevalence of and contributing factors to obesity among schoolchildren of Podgorica.

Method The sample included 1,134 schoolchildren (49.8% boys) aged 7–12 years, from 10 elementary schools in Podgorica. We measured children's body mass, body height, and waist circumference to calculate body mass index (BMI) and waist-to-height ratio. The research instrument was a closed type of the original questionnaire. Nutritional status was assessed according to the criteria recommended by the American Centers for Disease Control and Prevention, World Health Organization and International Obesity Task Force.

Results Among the investigated children there were 21.2% and 6% overweight and obese children, respectively. Obesity was more frequent among boys (7.6%) compared to girls (4.4%). In a multiple regression, childhood obesity was positively related to the following: male gender, younger age, lower number of siblings, parental obesity, and low physical activity.

Conclusion One out of five urban Montenegrin schoolchildren is overweight/obese, with obesity being twice as frequent among boys compared to girls. A program against obesity among urban Montenegrin children should focus on the revealed contributing factors.

Keywords: children; overweight; obesity; body mass index

INTRODUCTION

Obesity is a disease and one of the most common metabolic disorders nowadays. In 2015, the number of overweight/obesity (OWOb) children worldwide is about 1.5 billion. Childhood obesity (COb) is an emerging public health problem. In 2010, the number of OWOb children under the age of five amounted to over 42 million, 35 million of which come from developing countries. In the European Union, about 22 million children are overweight, five million of which are obese [1].

Complications of COb include hypertension, dyslipidemia, premature puberty, ovarian hyperandrogenism, orthopedic complications, sleep apnea, as well as psycho-social problems. Investigation of childhood obesity is approved by the fact that about 80% of obese children are prone to be obese in adult life [2].

Only one national study on childhood obesity has been carried out in Montenegro so far [3]. In this study we focus on the largest Montenegrin urban area, as the overwhelming majority of Montenegrin population is urban.

The aim of this study was to investigate OWOb and contributing factors among schoolchildren of Podgorica.

METHODS

The sample consisted of 1,134 schoolchildren aged 7–12 years from 10 elementary schools in Podgorica with similar gender distribution (49.8% boys). The response rate of positive parental answers on a request for interviewing and examination of children was 71% (1,597 letters delivered). To obtain representativeness, a two-stage cluster sample was determined. In the first step, 10 schools were randomly selected from the list of 30 primary schools in Podgorica. In the second step, one class from each of the second to the seventh class generations was
randomly selected from each school. We used a questionnaire, which consisted of five parts. The first part included socio-economic data (date of birth, gender, class, parental education, family income). The second part was related to parental body weight and height and smoking habits. The third part was related to child’s weight at birth, term of birth (premature birth = before the 36th week of gestation), and breastfeeding. The fourth section was related to child’s physical activity, watching television and playing on a computer. The fifth section was related to child’s dietary habits in terms of consumption frequency of specific food groups.

Anthropometric measurements were performed in the schools from December 2012 to February 2013. Body height was measured using a stadiometer (Gima S.p.A., Gessate, Italy) accurate to 0.1 cm. Body weight was measured on barefoot children in light clothes, using a digital scale (Seca GmbH & Co. KG., Hamburg, Germany) accurate to 0.1 kg. Body mass index (BMI) was calculated dividing body weight in kilograms by the square of height in meters. Waist circumference was measured by a measuring tape midway between the lower edge of the rib cage and the upper edge of the iliac bone, accurate to 0.1 cm. In order to make the results of our study comparable with similar researches worldwide, we assessed the children’s nutritional status using the following three current criteria: World Health Organization (WHO), the American Centers for Disease Control and Prevention (CDC), and International Obesity Task Force (IOTF) [4, 5, 6].

WHO growth reference for school-aged children and adolescents for ages 5–19 defines obesity and overweight as BMI > 2 standard deviations (SD), and BMI > 1 SD above the WHO growth standard median, respectively. Underweight is defined as BMI < 2 SD below the WHO growth standard median.

In the CDC Growth Charts for children and adolescents age 2–19, BMI is assessed by age and sex-specific percentiles: underweight < 5th percentile; normal weight 5th percentile to < 85th percentile; overweight – 85th percentile to < 95th percentile, and obesity ≥ 95th percentile. IOTF provides BMI cut points by age and sex for thinness, overweight, and obesity for children and adolescents age 2–18. The cut points correspond to an adult BMI of 16.5 (thinness grade 1); BMI 17 (thinness grade 2); BMI 18.5 (thinness grade 3); BMI 25 (overweight), or BMI 30 (obesity). We used cut points for thinness grade 2 to define children’s underweight because they are closest to the WHO standard for underweight.

In a statistical analysis of categorical variables we used the Pearson’s $\chi^2$ test. To test whether there was a statistically significant difference in numerical variables between two groups of children we used Student’s t-test, whereas in cases of three or more groups we used the ANOVA test. In a logistic regression, univariate and multiple, childhood overweight/obesity was a dependent variable, while relevant socio-demographic and personal variables were independent variables.

**RESULTS**

The investigated children were homogeneously distributed by gender and grade (Table 1).

Depending on the applied criteria, overweight/obesity was found in every fourth (IOTF) or even every third child (WHO). Obesity was from 1.7 times (IOTF) to 2.5 times (WHO) more frequent among boys compared to girls. IOTF criteria were more restrictive concerning childhood obesity showing a two times lower obesity prevalence (6%) compared to WHO criteria (12.2%) (Table 2).

Out of 23 investigated factors, the following nine showed significant influence on the onset of childhood overweight/obesity in a univariate regression analysis: gender, age, number of children in the family, order of birth, maternal obesity, paternal obesity, macrosomia at birth, and daily watching TV (Table 3).

In a multiple regression there were six contributing factors to childhood obesity that remained significant: boys had one third higher chance for obesity than girls, there was 12% lower chance for obesity per each year of age; every next child in a family had one third lower chance to become obese compared to the previous one; obese parents raised the chance of their child becoming obese by 100%; each day of the week with at least one hour of physical activity lowered the chance of a child being obese by 10% (Table 4).

**Table 1.** Distribution of investigated children by school grade and gender

<table>
<thead>
<tr>
<th>Grade</th>
<th>Gender</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>First</td>
<td>97</td>
<td>86</td>
</tr>
<tr>
<td>Third</td>
<td>92</td>
<td>89</td>
</tr>
<tr>
<td>Fourth</td>
<td>115</td>
<td>106</td>
</tr>
<tr>
<td>Fifth</td>
<td>88</td>
<td>100</td>
</tr>
<tr>
<td>Sixth</td>
<td>89</td>
<td>108</td>
</tr>
<tr>
<td>Seventh</td>
<td>84</td>
<td>80</td>
</tr>
<tr>
<td>Total</td>
<td>565</td>
<td>568</td>
</tr>
</tbody>
</table>

Pearson’s $\chi^2 = 4.90, p = 0.557$

**Table 2.** Nutritional status of children aged 7–12 years from Podgorica, Montenegro, according to the criteria of the World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), and International Obesity Task Force (IOTF) (n[%])

<table>
<thead>
<tr>
<th>Nutritional status</th>
<th>WHO</th>
<th>CDC</th>
<th>IOTF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>Total</td>
</tr>
<tr>
<td>Underweight</td>
<td>5 (0.9)</td>
<td>15 (2.6)</td>
<td>20 (1.8)</td>
</tr>
<tr>
<td>Normal</td>
<td>349 (61.6)</td>
<td>413 (72.7)</td>
<td>762 (67.2)</td>
</tr>
<tr>
<td>Overweight</td>
<td>113 (20)</td>
<td>101 (17.8)</td>
<td>214 (18.9)</td>
</tr>
<tr>
<td>Obesity</td>
<td>99 (17.5)</td>
<td>39 (6.9)</td>
<td>138 (12.1)</td>
</tr>
<tr>
<td>Total</td>
<td>566 (100)</td>
<td>568 (100)</td>
<td>1,134 (100)</td>
</tr>
</tbody>
</table>
There were no significant differences in dietary habits either between obese and normal-weight children or between boys and girls.

Among boys we found a 15 minute longer average daily period playing on a computer compared to girls (1.3 ± 0.8 h vs. 1.1 ± 0.7 h; t = 4.1; p = 0.001; Student's t-test).

**DISCUSSION**

According to the latest IOTF criteria, the proportion of overweight schoolchildren in Podgorica is 21.2%, while 6% of children are obese. Obesity is two times more frequent among boys compared to girls. Compared to EU countries, the prevalence of obesity among urban Montenegrin children is similar to that in Luxembourg, Ireland and Israel (22%). Regarding OECD data from 2014, the highest prevalence of OWOb was recorded in Greece (44% of boys and 38% of girls) followed by Italy (36% vs. 34%), New Zealand (34% vs. 34%), USA (30% vs. 30%), while the lowest prevalence was recorded in Indonesia (11% vs. 8%). Differences between prevalence of OWOb in favor of boys were found in China (24% vs. 16%), Hungary (28% vs. 23%), Poland (17% vs. 11%), whereas differences in favor of girls are present in South Africa (29% vs. 11%) and UK (26% vs. 22%) [7].

We revealed parental BMI as the most important independent contributing factor to childhood obesity. Children who have at least one obese parent, are two times more likely to be obese than children whose both parents' weight is normal. This has been partly explained by genetic influences, but mostly by the fact that children often share food habits and sedentary lifestyle with their parents [8].

A strong correlation between children's and parental BMI was also found in a Greek study and in a Swedish study [9, 10].

<p>| Table 3. Univariate logistic regression with child overweight/or obesity (IOTF) as a dependent variable and some relevant factors for childhood obesity as independent variables (n = 1,113) |</p>
<table>
<thead>
<tr>
<th>Independent variable</th>
<th>OR</th>
<th>95% CI</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (male = 1; female = 2)</td>
<td>0.68</td>
<td>0.52–0.88</td>
<td>0.004</td>
</tr>
<tr>
<td>Age (per year)</td>
<td>0.87</td>
<td>0.81–0.95</td>
<td>0.001</td>
</tr>
<tr>
<td>Maternal education</td>
<td>1.06</td>
<td>0.92–1.22</td>
<td>0.438</td>
</tr>
<tr>
<td>Paternal education</td>
<td>0.92</td>
<td>0.79–1.07</td>
<td>0.258</td>
</tr>
<tr>
<td>Maternal employment (Yes = 1; No = 0)</td>
<td>0.97</td>
<td>0.74–1.26</td>
<td>0.803</td>
</tr>
<tr>
<td>Paternal employment (Yes = 1; No = 0)</td>
<td>0.97</td>
<td>0.72–1.30</td>
<td>0.823</td>
</tr>
<tr>
<td>Living with both parents (Yes = 1; No = 0)</td>
<td>0.68</td>
<td>0.45–1.03</td>
<td>0.071</td>
</tr>
<tr>
<td>Number of children in the family (per child)</td>
<td>0.73</td>
<td>0.63–0.84</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Order of birth</td>
<td>0.65</td>
<td>0.54–0.77</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Family income</td>
<td>0.93</td>
<td>0.71–1.22</td>
<td>0.592</td>
</tr>
<tr>
<td>Apartment area per tenant (m²)</td>
<td>1.00</td>
<td>0.99–1.01</td>
<td>0.830</td>
</tr>
<tr>
<td>Rooms per tenant</td>
<td>0.96</td>
<td>0.75–1.23</td>
<td>0.731</td>
</tr>
<tr>
<td>Maternal smoking (Yes = 1; No = 0)</td>
<td>1.25</td>
<td>0.94–1.65</td>
<td>0.124</td>
</tr>
<tr>
<td>Paternal smoking (Yes = 1; No = 0)</td>
<td>0.90</td>
<td>0.68–1.18</td>
<td>0.436</td>
</tr>
<tr>
<td>Maternal overweight/obesity (Yes = 1; No = 0)</td>
<td>2.01</td>
<td>1.50–2.70</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Paternal overweight/obesity (Yes = 1; No = 0)</td>
<td>2.03</td>
<td>1.41–2.91</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Macrosomia at birth (≥ 4,000 g = 1; &lt; 4,000 g = 0)</td>
<td>1.63</td>
<td>1.17–2.28</td>
<td>0.004</td>
</tr>
<tr>
<td>Preterm birth (before the 36th gestational week = 1; on the 36th gestational week and after = 0)</td>
<td>1.17</td>
<td>0.77–1.79</td>
<td>0.468</td>
</tr>
<tr>
<td>Child breastfed (Yes = 1; No = 0)</td>
<td>0.99</td>
<td>0.71–1.39</td>
<td>0.960</td>
</tr>
<tr>
<td>Daily watching TV (per hour)</td>
<td>1.13</td>
<td>1.01–1.26</td>
<td>0.031</td>
</tr>
<tr>
<td>Daily playing on computer (per hour)</td>
<td>1.06</td>
<td>0.89–1.28</td>
<td>0.509</td>
</tr>
<tr>
<td>Physical activity at least one hour out of school (days per week)</td>
<td>0.91</td>
<td>0.85–0.98</td>
<td>0.011</td>
</tr>
<tr>
<td>Duration of night sleep (per hour)</td>
<td>0.94</td>
<td>0.84–1.05</td>
<td>0.253</td>
</tr>
</tbody>
</table>

<p>| Table 4. Multivariate logistic regression with child overweight/or obesity (IOTF) as a dependent variable and some relevant factors for childhood obesity as independent variables (n = 1,113) |</p>
<table>
<thead>
<tr>
<th>Independent variable</th>
<th>OR</th>
<th>95% CI</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (male = 1; female = 2)</td>
<td>0.64</td>
<td>0.47–0.88</td>
<td>0.007</td>
</tr>
<tr>
<td>Age (per year)</td>
<td>0.88</td>
<td>0.80–0.96</td>
<td>0.007</td>
</tr>
<tr>
<td>Number of children in the family (per child)</td>
<td>0.83</td>
<td>0.68–1.02</td>
<td>0.072</td>
</tr>
<tr>
<td>Order of birth</td>
<td>0.70</td>
<td>0.55–0.90</td>
<td>0.005</td>
</tr>
<tr>
<td>Maternal overweight/obesity (Yes = 1; No = 0)</td>
<td>2.18</td>
<td>1.55–3.07</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Paternal overweight/obesity (Yes = 1; No = 0)</td>
<td>2.18</td>
<td>1.45–3.27</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Macrosomia at birth (≥ 4,000 g = 1; &lt; 4,000 g = 0)</td>
<td>1.41</td>
<td>0.95–2.10</td>
<td>0.092</td>
</tr>
<tr>
<td>Daily watching of TV (per hour)</td>
<td>1.15</td>
<td>1.00–1.33</td>
<td>0.056</td>
</tr>
<tr>
<td>Physical activity at least one hour out of school (per day in a week)</td>
<td>0.91</td>
<td>0.84–0.99</td>
<td>0.029</td>
</tr>
</tbody>
</table>

OR – odds ratio; CI – confidence interval
has stronger impact on COb, as results of studies conducted
to date are equivocal [11].

We show a negative correlation between the number of
children in a family and COb. Chen and Escarce [12] have also found that in the eighth grade children with no
siblings had higher BMI and higher probability of being
obese than their counterparts with two or more siblings.
It may be assumed that an inexperienced mother is prone
to overfeeding her child. However, research on the effect
of family structure on COb still remains unclear [12].

We found a positive correlation between macrosomia
at birth and COb. There is a strong scientific agreement
that body mass at birth significantly influences obesity in
later childhood [15]. It has been suggested that adolescent
obesity rate raises from 2.6% to 5.6% for birth weights
4,000–4,500 g and ≥ 4,500 g, respectively, and therefore a
refined definition of macrosomia with 4,500 g as the cutoff
point could be considered [16].

We found that longer daily television watching explains
more frequent obesity among boys compared to girls.

Braithwaite et al. [17] examining 207,672 adolescents
from 37 countries found that children who spent longer
time watching TV had a significantly increased BMI. In
another study it was shown that children who watched
TV for more than four hours daily had significantly higher
BMI. In

A strong association between COb and smoking has been
found in many studies. However, the exact mechanism by
which smoking leads to an increase in BMI is not fully
understood. Several studies have suggested that tobacco
smoke may lead to alterations in the hypothalamic regula-
tory centers of energy balance, which in turn may

knai et al. [24] conducted a study in 22 European coun-
tries and showed that modest personal income is associ-
ated with a higher prevalence of obesity among children
but also among adults, and also that obesity particularly
affects certain ethnic groups.

We show no significant correlation between parental
smoking and COb. Previous studies showed that increased
concentration of nicotine leads to an alteration of hypothalamic regulatory centers of energy
production and consumption in mother, which could hypo-
theically affect the newborn’s weight [25].

A strong association between cigarette smoking during
pregnancy and OWOb was described by Kleiser et al. [26].

Data brought by Canadian cohort study on the impact
of tobacco smoke on a child’s BMI showed that prenatal
exposure of a child to tobacco smoke is associated with
moderately lower BMI later during childhood, and that
postnatal exposure to tobacco smoke was associated with
a moderately increased BMI [27]. However, given the mul-
tifactorial nature of obesity, isolated biological effects
of smoking on BMI remain unclear.

We found no significant correlation between the pre-
term birth and COb. This finding is opposite to the results
of Vasylyeva et al. [28], who found a positive correlation
between the preterm birth and increased weight later in
childhood.

Our study does not prove a significant link between
breastfeeding and childhood obesity. According to some
studies, breastfeeding reduces the risk of a child becoming
obese [29]. However, an analysis of common myths
about obesity points out a clear publication bias concern-
ing breastfeeding and COb [30].

CONCLUSION

We show that about every fourth urban child in Montene-

gro is OWOb, with obesity being twice as frequent among
boys compared to girls. We also reveal the correlates of
COb. The findings of our study will serve as a cornerstone
of a preventive program against COb in Montenegrin ur-
ban areas.

ACKNOWLEDGMENT

The study was financially supported by the Montenegrin
Ministry of Science, contract No. 01-1366/2012.

NOTE

This paper has derived from the first author’s MSc thesis,
within a project titled “Investigation of obesity and poverty
among the children of Montenegro – clinical, pathophysi-
ological, biochemical and preventive aspects (PI – Milica
Martinović).” The study has been approved by the Eth-
ics Committee of the Faculty of Medicine, University of
Montenegro.
REFERENCES


20. Department of Health UK. Start Active, Stay Active: A report on physical activity for health from the four home countries' Chief Medical Officers; 2011.


Преваленца и чиниоци који доприносе настанку прекомерне телесне масе и гојазности код школске деце у Подгорици, Црна Гора

Марина Јакшић1, Милица Мартиновић2, Горан Белојевић3, Небојша Каварић4, Богдан Ашанин5, Мира Самарџић6, Снежана Пантовић7, Јелена Бољевић1
1Клинички центар Црне Горе, Центар за клиничко-лабораторијску дијагностику, Подгорица, Црна Гора;
2Универзитет Црне Горе, Медицински факултет, Катедра за патолошку физиологију и лабораторијску медицину, Подгорица, Црна Гора;
3Универзитет у Београду, Медицински факултет, Институт за хигијену са медицинском екологијом, Београд, Србија;
4Дом здравља, Подгорица, Црна Гора;
5Универзитет Црне Горе, Медицински факултет, Клиника за неурорхирургију, Подгорица, Црна Гора;
6Клинички центар Црне Горе, Институт за дјечије болести, Подгорица, Црна Гора;
7Универзитет Црне Горе, Медицински факултет, Одсек за биохемију, Подгорица, Црна Гора

САЖЕТАК
Увод/Циљ Дечја гојазност је актуелни народноздравствени проблем. Национална преваленција деце гојазности у Црној Гори увећана је за трећину у последњој деценији. Како је изразита већина црногорског становништва у градовима, од посебног народноздравственог интереса је истраживање гојазности и корелирајућих чиниоца код градске деце. Циљ рада је био да се истраже преваленција и доприносећи чиниоци за гојазност међу школским децом Подгорице.

Методе Узорак је обухватао 1.134 школска детета (49,8% дећака) узраста 7–12 година, из десет основних школа у Подгорици. Деци смо измерили телесну масу, телесну висину и обим струка, како бисмо израчунали индекс телесне масе и однос струка и висине. Инструмент истраживања био је оригинални упитник затвореног типа. Стање ухрањености је процењено на основу критеријума препоручених од стране Америчког центра за контролу и превенцију болести, Светске здравствене организације и Међународне радне групе за борбу против гојазности.

Резултати Међу испитиваном децом 21,2% је имало прекомерну телесну масу, док је 6% било гојазно. Гојазност је чешће била присутна међу дечацима (7,6%) у односу на девојчице (4,4%). У вишеструкој регресионој анализи дечја гојазност је била у позитивној вези са мушким полом, млађом животном доби, мањим бројем деце у породици, гојазношћу родитеља и ниским степеном физичке активности.

Закључак Свако пето градско дете у Црној Гори је са прекомерном телесном масом или је гојазно, са два пута чешћем узастопашћу гојазности код дечака у односу на девојчице. Програм против гојазности код градске деце биће усмерен на откривене доприносећи чиниоци.

Кључне речи: деца; прекомерна телесна маса; гојазност; индекс телесне масе.