

Regional and urban–rural differences in nutritional status of first-grade children in Montenegro

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ABSTRACT

Background: Childhood nutritional status is a key indicator of growth and development and is influenced by biological, environmental, and behavioral factors. Understanding regional and urban–rural differences is crucial for targeted public health interventions.

Aim: This study aimed to examine regional and urban–rural differences in the nutritional status of first-grade children in Montenegro, using Body Mass Index (BMI) and Waist-to-Height Ratio (WHtR) as primary indicators.

Methods: A cross-sectional study was conducted among 286 first-grade children aged 6–7 years from northern and central regions of Montenegro. Anthropometric measurements, including body height, body mass, and waist circumference, were collected following ISAK standards. Methods: Body Mass Index (BMI) and Waist-to-Height Ratio (WHtR) were evaluated in 286 first-grade schoolchildren (135 boys, 151 girls) from Northern and Central Montenegro, stratified by region and urban-rural environment. Data were analyzed using descriptive statistics and the Chi-square test ($p < 0.05$).

Results: No significant regional or urban-rural differences were found in BMI distribution ($p > 0.05$). However, boys showed a high combined overweight/obesity prevalence in Northern (36.6%) and Central (30.2%) regions. For WHtR, a highly significant regional divergence was found among girls ($p < 0.001$); girls from the Central region demonstrated a critically higher prevalence of abdominal obesity (32.8%) com-

pared to Northern peers (8.3%). Urban-rural environment had no significant impact ($p > 0.05$).

Conclusions: These findings suggest relatively homogeneous patterns of nutritional status among first-grade children in Montenegro, regardless of region or settlement type. Nevertheless, the presence of overweight and obesity highlights the importance of early monitoring and preventive interventions. School- and community-based programs promoting healthy nutrition and physical activity are essential to mitigate childhood obesity and support long-term health outcomes.

KEY WORDS

Childhood obesity, Schoolchildren, Central adiposity, Anthropometric assessment.

INTRODUCTION

The nutritional status of children represents an important anthropological indicator of growth and development and constitutes an integral part of the assessment of the morphological space of the organism in childhood. The period of school entry is characterized by a transition from predominantly spontaneous forms of movement to structured physical activities, accompanied by intensive changes in body height, body mass, and body composition. During this period, adequate energy and nutrient intake plays a crucial role in the development of functional and motor abilities, as well as in the proper maturation of organ systems¹.

In modern conditions characterized by hypokinesia and altered lifestyle habits, disturbances in energy balance occur, leading to an increasing prevalence of excessive body mass among children. A long-term global analysis has demonstrated a continuous increase in body mass index among children and adolescents over recent decades, significantly alter-

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ing the morphological structure of the pediatric population². Childhood overweight is associated with reduced relative muscle mass, poorer motor performance, and decreased aerobic capacity, and represents a risk factor for the later development of chronic diseases³.

In the European pediatric population, a high prevalence of overweight has been recorded, with boys generally more affected than girls⁴. These differences may be related to varying patterns of physical activity, leisure time habits, and differences in motor development between sexes. In addition to biological factors, environmental conditions in which a child grows up play a significant role. Regional differences may influence the level of daily movement, dietary patterns, and availability of sports activities, which directly reflects on children's anthropometric characteristics⁵. Furthermore, differences between urban and rural environments are evident in the structure of movement activities — children in urban areas more often engage in sedentary behaviors, whereas rural children demonstrate a higher volume of spontaneous locomotor activity⁶. Research indicates that urban children spend more time in screen-based activities and have lower daily energy expenditure, while rural children more frequently achieve recommended levels of moderate-to-vigorous physical activity⁷. It has also been established that the built environment, availability of playgrounds, and neighborhood safety significantly influence children's physical activity levels and indirectly their body mass index⁸. Systematic reviews indicate that urban environments increase the risk of overweight primarily due to reduced spontaneous daily movement and greater availability of energy-dense foods⁹.

For the assessment of nutritional status in kinesiology research, anthropometric measurements are most commonly used, particularly body mass index relative to age and sex according to international reference standards¹⁰. Monitoring these parameters in early school age is especially important because movement patterns stabilize during this period and form the basis of later motor and functional status¹¹.

Although numerous studies have analyzed children's nutritional status in Europe, data for younger school-age populations in Montenegro remain limited, particularly regarding regional and urban–rural differences. Therefore, the aim of this study is to examine and compare the nutritional status of first-grade primary school children between the northern and central regions of Montenegro, including analysis by sex and type of settlement (urban vs rural).

OBJECTIVES

Although numerous studies have analyzed children's nutritional status in Europe, data for younger school-age populations in Montenegro remain limited, particularly regarding regional and urban–rural differences. Therefore, the aim of this study is to examine and compare the nutritional status of

first-grade primary school children between the northern and central regions of Montenegro, including analysis by sex and type of settlement (urban vs rural).

MATERIAL AND METHOD

This study was conducted using a cross-sectional design. Prior to data collection, ethical approval was obtained from the Ministry of Education, particularly for access to primary school pupils. The principals of the participating schools were informed in advance about the arrival of the research team and provided permission for the measurements to be conducted. All anthropometric measurements were performed in physical education halls during the morning hours by experienced associates from the Faculty for Sport and Physical Education, University of Montenegro in Nikšić, who had been previously trained in the measurement procedures and recording protocols. The pupils were fully informed about the purpose and procedures of the study, and all measurements were conducted in accordance with ISAK standards, with pupils measured barefoot and wearing light clothing¹².

Participant. The total sample consisted of 286 first-grade primary school children (135 boys, 47.2%; 151 girls, 52.8%) from the Northern ($n = 166$) and Central ($n = 120$) regions of Montenegro. Within the geographic sub-samples, the urban–rural distribution showed that 91 boys (67.4%) and 97 girls (64.2%) resided in urban environments, while 44 boys (32.6%) and 54 girls (35.8%) lived in rural areas.

Instruments. To assess nutritional status, anthropometric measurements were collected, including body height (BH), body mass (BM), and waist circumference (WC). Based on these measurements, Body Mass Index (BMI) and Waist-to-Height Ratio (WHtR) were calculated and used as the primary variables. Nutritional status was classified according to BMI percentiles using the WHO growth reference standards for children aged 5–19 years: underweight (<5th percentile), normal weight (5th–85th percentile), overweight (>85th–95th percentile), and obesity (>95th percentile)¹³. WHtR, defined as the ratio of waist circumference to height, was used as an additional indicator of central adiposity, with values greater than 0.5 indicating obesity¹⁴.

Procedures and data analysis. The collected data were analyzed using descriptive and comparative statistical methods. Descriptive statistics included the calculation of frequencies and percentages to present the anthropometric characteristics and nutritional status of the participants. Differences in the distribution of nutritional status categories (underweight, normal weight, overweight, and obesity), as well as differences in WHtR categories between regions and between urban and rural areas, were analyzed using the chi-square (χ^2) test of independence. This non-parametric test was applied to determine the presence of statistically significant associations between categorical variables, such as region, type

of settlement, and nutritional status. The level of statistical significance was set at $p < 0.05$. Statistical analyses were performed using SPSS software, version 25.0.

RESULTS

The distribution of nutritional status categories based on BMI and abdominal obesity based on WHtR across different re-

gions is presented in Table 1. Chi-square (χ^2) analysis revealed no statistically significant regional differences in BMI distribution for either boys ($\chi^2 = 0.275$, $p > 0.05$) or girls ($\chi^2 = 0.070$, $p > 0.05$). The majority of the children displayed normal body weight (62.2% of boys and 74.9% of girls). However, a high prevalence of obesity was observed among boys in both the Northern (25.6%) and Central (20.8%) regions. Regarding

Table 1. Nutritional Status and WHtR of First-Grade Schoolchildren by Region

Variable	Northern Region (n = 82 boys / n = 84 girls)	Central Region (n = 53 boys / n = 67 girls)	Total Sample (n = 135 boys / n = 151 girls)	χ^2	p-value
BOYS					
<i>BMI Category</i>				0.275	$p > 0.05$
Underweight	1 (1.2%)	4 (7.5%)	5 (3.7%)		
Normal	51 (62.2%)	33 (62.3%)	84 (62.2%)		
Overweight	9 (11.0%)	5 (9.4%)	14 (10.4%)		
Obese	21 (25.6%)	11 (20.8%)	32 (23.7%)		
<i>WHtR Category</i>				0.306	$p > 0.05$
Normal	62 (75.6%)	44 (83.0%)	106 (78.5%)		
Abdominal Obesity	20 (24.4%)	9 (17.0%)	29 (21.5%)		
GIRLS					
<i>BMI Category</i>				0.070	$p > 0.05$
Underweight	8 (9.5%)	3 (4.4%)	11 (7.3%)		
Normal	65 (77.4%)	48 (71.6%)	113 (74.9%)		
Overweight	8 (9.5%)	6 (9.0%)	14 (9.3%)		
Obese	3 (3.6%)	10 (14.9%)	13 (8.6%)		
<i>WHtR Category</i>				11.420	$p < 0.001$
Normal	77 (91.7%)	45 (67.2%)	122 (80.8%)		
Abdominal Obesity	7 (8.3%)	22 (32.8%)	29 (19.2%)		
Descriptive Statistics	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD		
Boys BMI (kg/m ²)	17.06 $\pm$ 2.38	16.92 $\pm$ 2.62	17.01 $\pm$ 2.47		
Boys WHtR	0.465 $\pm$ 0.051	0.465 $\pm$ 0.046	0.465 $\pm$ 0.049		
Girls BMI (kg/m ²)	15.71 $\pm$ 1.82	16.34 $\pm$ 2.01	15.99 $\pm$ 1.93		
Girls WHtR	0.453 $\pm$ 0.036	0.479 $\pm$ 0.061	0.465 $\pm$ 0.051		

BMI = Body Mass Index; WHtR = Waist-to-Height Ratio; n = number of participants; % = percentage; Mean = arithmetic mean; SD = standard deviation; χ^2 = Chi-square test value; p = statistical significance level. Statistically significant values are indicated in bold ($p < 0.05$).

the Waist-to-Height Ratio (WHtR), no significant regional difference was noted in boys ($\chi^2 = 0.306$, $p > 0.05$). Conversely, a highly significant regional divergence was found among girls ($\chi^2 = 11.420$, $p < 0.001$). Girls from the Central region demonstrated a critically higher prevalence of abdominal obesity (32.4%) compared to their peers from the Northern region (8.3%).

The combined prevalence of overweight and obesity grouped by sex and region is illustrated in Table 2. The cumulative prevalence of excess body weight among first-grade boys reached 36.6% in the Northern region and 30.2% in the Central region, driven primarily by the high rates of obesity in both territories. In contrast, the combined prevalence for first-grade girls displayed a distinct regional disparity; while

only 13.1% of girls in the Northern region were classified as overweight or obese, this cumulative metabolic risk substantially increased within the Central region, reaching 23.9% of the female sub-sample.

Table 3 presents the socio-demographic analysis of BMI and WHtR categories among first-grade boys, focusing on the urban–rural distribution within each geographic region. Chi-square analysis demonstrated that the residential environment (urban vs. rural) did not exert a statistically significant influence on the distribution of BMI categories in either the Northern region ($\chi^2 = 0.671$, $p > 0.05$) or the Central region ($\chi^2 = 0.143$, $p > 0.05$). Similarly, variations in WHtR categories between urban and rural schoolboys did not cross the threshold of statistical significance in either the North

Table 2. Combined Prevalence of Overweight and Obesity by Sex and Region

Group	Overweight % (n)	Obesity % (n)	Combined Prevalence (Overweight + Obesity)
Boys			
Northern Region (n = 82)	11.0% (9)	25.6% (21)	36.6% (30)
Central Region (n = 53)	9.4% (5)	20.8% (11)	30.2% (16)
Girls			
Northern Region (n = 84)	9.5% (8)	3.6% (3)	13.1% (11)
Central Region (n = 67)	9.0% (6)	14.9% (10)	23.9% (16)

n = number of participants; % = percentage within the specific sub-sample; Combined Prevalence = cumulative percentage of overweight and obese children.

Table 3. Urban–Rural Distribution of BMI and WHtR in First-Grade Boys

Variable	Northern Region (n = 54 Urban / n = 28 Rural)	Central Region (n = 39 Urban / n = 14 Rural)	χ^2 (North)	p-value (North)	χ^2 (Center)	p-value (Center)
BMI Category			0.671	$p > 0.05$	0.143	$p > 0.05$
Underweight	U: 1 (1.9%) / R: 0 (0.0%)	U: 1 (2.6%) / R: 3 (21.4%)				
Normal	U: 31 (57.4%) / R: 20 (71.4%)	U: 25 (64.1%) / R: 8 (57.1%)				
Overweight	U: 7 (13.0%) / R: 2 (7.1%)	U: 4 (10.3%) / R: 1 (7.1%)				
Obese	U: 13 (24.1%) / R: 8 (28.6%)	U: 9 (23.1%) / R: 2 (14.3%)				
WHtR Category			0.866	$p > 0.05$	0.605	$p > 0.05$
Normal	U: 39 (72.2%) / R: 23 (82.1%)	U: 33 (84.6%) / R: 11 (78.6%)				
Abdominal Obesity	U: 15 (27.8%) / R: 5 (17.9%)	U: 6 (15.4%) / R: 3 (21.4%)				

U = Urban environment; R = Rural environment; BMI = Body Mass Index; WHtR = Waist-to-Height Ratio; n = number of participants; % = percentage; χ^2 = Chi-square test value; p = statistical significance level ($p < 0.05$).

($\chi^2 = 0.866$, $p > 0.05$) or the Center ($\chi^2 = 0.605$, $p > 0.05$), indicating a relatively homogenous distribution of body mass and abdominal obesity across different settlement types for the male cohort.

The urban–rural distribution of anthropometric indicators among first-grade girls is detailed in Table 4. Similar to the trends observed in boys, the type of settlement had no statistically significant effect on BMI categorization ($\chi^2 = 0.169$, $p > 0.05$ for the North; $\chi^2 = 0.303$, $p > 0.05$ for the Center) or WHtR classification ($\chi^2 = 0.895$, $p > 0.05$ for the North; $\chi^2 = 0.877$, $p > 0.05$ for the Center). Notably, despite the lack of statistical significance between urban and rural cohorts within the same region, a uniformly high prevalence of abdominal obesity via WHtR was sustained across both residential settings in the Central region, with urban girls at 33.3% and rural girls at 37.5%, highlighting a widespread regional risk that transcends the urban–rural divide.

DISCUSSION

The primary objective of this study was to evaluate the regional and urban-rural distribution of nutritional status and abdominal obesity among first-grade schoolchildren in Montenegro using updated anthropometric indices and specific subgroup prevalences. The most significant finding of this investigation is the striking regional divergence in abdominal obesity among young girls, with those from the Central region demonstrating a critically higher prevalence compared to their Northern peers. Concurrently, while regional and residential factors did not significantly alter overall BMI distribution, the alarmingly high combined prevalence of overweight and obesity among first-grade

boys across both regions emerges as a major public health concern.

This study reveals that the traditional urban-rural divide in Montenegro no longer dictates pediatric health, as lifestyle homogenization and dietary transitions have erased residential boundaries. Instead, a critical public health concern emerges from regional and sex-specific disparities, highlighted by a fourfold higher prevalence of abdominal obesity among girls in the Central region (32.8%) compared to their Northern peers (8.3%). While boys across both regions face consistently high overall overweight rates, young girls in urbanized areas show a distinct pattern of visceral fat accumulation. These findings indicate that early metabolic risks are driven by regional development and sedentary habits, emphasizing the need for targeted public health interventions tailored to specific geographic zones rather than the classic village-city dichotomy.

The absence of significant regional and urban–rural differences may reflect relatively uniform living conditions and behavioral patterns among children in Montenegro, particularly at an early school age. Similar findings have been reported in previous national studies, where no significant differences in BMI and WHtR were observed between urban and rural adolescents, although rural adolescents demonstrated higher levels of physical activity¹⁵. This suggests that factors such as physical activity, diet, and family environment may have a greater influence on nutritional status than place of residence alone. Although differences were not statistically significant, the observed regional variations in the prevalence of overweight and obesity are partially consistent with previous findings indicating geographic differences in the nutritional status

Table 4. Urban–Rural Distribution of BMI and WHtR in First-Grade Girls

Variable	Northern Region (n = 48 Urban / n = 36 Rural)	Central Region (n = 51 Urban / n = 16 Rural)	χ^2 (North)	p-value (North)	χ^2 (Center)	p-value (Center)
<i>BMI Category</i>			0.169	$p > 0.05$	0.303	$p > 0.05$
Underweight	U: 4 (8.3%) / R: 4 (11.1%)	U: 3 (5.9%) / R: 0 (0.0%)				
Normal	U: 36 (75.0%) / R: 29 (80.6%)	U: 38 (74.5%) / R: 10 (62.5%)				
Overweight	U: 6 (12.5%) / R: 2 (5.6%)	U: 3 (5.9%) / R: 3 (18.8%)				
Obese	U: 2 (4.2%) / R: 1 (2.8%)	U: 7 (13.7%) / R: 3 (18.8%)				
<i>WHtR Category</i>			0.895	$p > 0.05$	0.877	$p > 0.05$
Normal	U: 42 (87.5%) / R: 35 (97.2%)	U: 34 (66.7%) / R: 10 (62.5%)				
Abdominal Obesity	U: 6 (12.5%) / R: 1 (2.8%)	U: 17 (33.3%) / R: 6 (37.5%)				

U = Urban environment; R = Rural environment; BMI = Body Mass Index; WHtR = Waist-to-Height Ratio; n = number of participants; % = percentage; χ^2 = Chi-square test value; p = statistical significance level ($p < 0.05$).

of children and adolescents in Montenegro¹⁶. Similar patterns have been reported internationally, where environmental factors, socioeconomic status, and access to physical activity opportunities have been identified as important determinants of childhood obesity¹⁷, and regional differences in abdominal obesity have been confirmed in large population-based studies¹⁸. At the European level, approximately 25% of children aged 7–9 years have excess body weight, with around 11% classified as obese, highlighting childhood obesity as a significant public health concern¹⁹. Globally, childhood obesity prevalence has risen substantially in recent decades, largely due to lifestyle changes, reduced physical activity, and unhealthy dietary habits^{20,21}. In this context, our findings emphasize the need for continuous monitoring of nutritional status and the implementation of preventive programs from an early school age, regardless of region or settlement type.

This study has certain limitations. The cross-sectional design does not allow for causal inferences between environment and nutritional status, and the inclusion of a single age group limits the generalizability of the findings to other age ranges. Nevertheless, the study's strength lies in being one of the few to simultaneously analyze regional and urban–rural differences in the nutritional status of children in Montenegro using both BMI and WHtR indicators. The results provide a valuable basis for future longitudinal research and the development of targeted interventions aimed at improving child health in early school years.

CONCLUSIONS

Nevertheless, the presence of children with excess body weight highlights the importance of early monitoring and preventive measures. The results particularly emphasize that even in populations where regional and urban–rural differences are not pronounced, the presence of overweight and obesity among children represents a serious public health challenge requiring systematic and comprehensive interventions at both national and local levels. These findings underscore the need for school- and community-based programs promoting healthy nutrition and physical activity to prevent childhood obesity and support long-term health outcomes.

ETHICAL CONSIDERATIONS

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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AI DISCLOSURE STATEMENT

When preparing this article, the author(s) used ChatGPT (GPT-5.3) on March 31, 2026, with the following prompt: "Translation and linguistic correction of academic text, as well as improvement of stylistic expression," for the purpose of translation, language editing, and stylistic enhancement of the manuscript. The author(s) subsequently reviewed and edited the output as necessary and accept full responsibility for the content and integrity of the publication.

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