PREVALENCE OF OBESITY AND IMPACT OF SOCIO-DEMOGRAPHIC FACTORS ON OBESITY IN 15–19 YEARS OLD ADOLESCENTS IN VOJVODINA, SERBIA

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SUMMARY

Objectives: The aim of this study was to examine the prevalence of overweight/obesity in 15–19 years old adolescents in the Province of Vojvodina, Serbia, and to evaluate the association between obesity and socio-demographic factors.

Methods: A cross-sectional study was conducted in high schools in the territory of Vojvodina, Serbia. The sample consisted of 986 high-school students (47.4% girls and 52.6% boys). Body height, body weight, and waist circumference were measured. Obesity was defined as a body mass index (BMI)-for-age value > $\overline{x}$ + 2 SD, and overweight as a BMI-for-age value > $\overline{x}$ + 1 SD and ≤ $\overline{x}$ + 2 SD. Waist-to-height ratio (WHtR) of ≥ 0.5 was considered high risk. Socio-demographic data was collected using a questionnaire developed for this study. Univariate and multivariate logistic regression analyses were implemented.

Results: The prevalence of overweight and obesity in adolescents was 19.6% and 10.1%, respectively. Boys were more likely to be obese than girls (OR = 1.87; 95% CI: 1.37–2.56). Adolescents living in suburban areas had a greater chance of obesity compared to those living in urban areas (OR = 1.84; 95% CI: 1.15–2.94), as well as those who attended trade schools compared to gymnasium students (OR = 1.92; 95% CI: 1.20–3.07). The lower level of the father's education was a significant predictor of obesity. Predictors of high-risk WHtR were gender, high school type, and the father's education level.

Conclusions: Obesity and abdominal obesity are highly prevalent in adolescents in Vojvodina, more in boys. Gender, community type and the level of the father's education were confirmed as significant factors that influenced both obesity and abdominal obesity. This study could help to customize health promotion policies for adolescents in Vojvodina.

Key words: obesity, prevention, adolescents, waist circumference, body mass index

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INTRODUCTION

Adolescence is a period of life between childhood and adulthood, marked by specific health and development needs and rights. One crucial determinant of the health, physical abilities, and potential for normal and healthy growth and development of young people is their nutrition. The epidemiology of chronic noncommunicable diseases and their risk factors is closely tied to excessive food consumption, eating habits, and lifestyle (1–3).

Numerous studies have demonstrated an upward trend in childhood overweight/obesity over the past few decades (1, 3, 4). The pathophysiology of obesity, a significant public health problem, is complex and results from a combination of individual and societal factors (family influence, community, and socio-economic resources) (5). According to the World Health Organization (WHO), overweight and obesity are defined as abnormal or excessive accumulation of fat that poses a health risk. The WHO has established growth standards for children depending on the age and gender (6, 7). Additionally, waist circumference (WC) and the waist-to-height ratio (WHtR) are considered effective indicators of abdominal obesity associated with cardiometabolic risk and have been shown to be valid predictors of future chronic diseases (8, 9). Overweight and obese adolescents face an increased risk of becoming over-nourished adults. They are at higher risk for developing chronic diseases such as hypertension, dyslipidaemia, type 2 diabetes, heart disease, stroke, gallbladder disease, osteoarthritis, sleep apnoea and respiratory problems, and certain types of cancers (3, 5).

According to WHO reports, the prevalence of childhood obesity has been steadily rising worldwide over the past four decades and remains higher among children and adolescents in developed countries. Among girls, it has increased eight times, reaching 5–6%, while among boys it has increased ten times, reaching 7–8%. In many high-income countries, the rising trends in children's and adolescents' body mass index (BMI) have pla-

teaued, though they remain high, but have accelerated in parts of Asia (10, 11).

Considering the last few years and the COVID-19 pandemic, reports from many countries have documented increased weight gain among children and adolescents during the pandemic compared with the rate before the pandemic caused by many different factors, for example, decreases in physical activity, increased screen time, changes in dietary intake, and increased family and individual stress (4, 12–14).

As in most transitioning countries, childhood overweight/obesity rates have also risen in Serbia in recent decades. According to some research, every third 7–9 years old child in Serbia is overweight or obese (15), and abdominal obesity based on WHtR is highly prevalent (14.6%) in Serbian adolescents 11–15 years old (16).

Numerous socioeconomic factors contribute to the rise in obesity among children and adolescents, including parental employment, education (individual and parental), and household income, which are recognized as crucial factors (5). There is clear evidence that higher parental education is associated with lower BMI. Also, there is evidence that higher parental education is connected to less genetic and environmental variation of BMI over the lifespan. However, parental education does not directly impact the development of overweight or obesity of children and adolescents; instead, it influences their behaviour and lifestyle factors. The family's socioeconomic status partially affects BMI by modifying genetic factors, and these effects are seen throughout adulthood, especially in obesogenic societies (17, 18).

To prevent obesity in the population, comprehensive long-term strategies must be implemented to create environments that support and facilitate healthy behaviours through evidence-informed intersectoral policy that tackles obesogenic environments and the commercial determinants of health. While policies should cater to all age groups, special attention should be paid to children, as small changes in their behaviour can lead to larger impacts on morbidity and mortality as they age and overweight develops and worsens (19).

The current study aimed to assess the prevalence of overweight/obesity in 15–19 years old adolescents in all seven districts of Vojvodina, Serbia, and to evaluate the association between obesity and socio-demographic factors.

MATERIALS AND METHODS

Study Design and Location

The cross-sectional study was conducted in September–December of the 2021/22 academic year. The study referred to the data obtained in ten government high schools located in all seven districts of the province of Vojvodina. The estimated prevalence of overweight and obesity in the population of Vojvodina (20.2%) was used to determine the sufficient sample size, which was 248. The sampling was conducted in two stages. In the first stage, out of 129 government high schools in the province of Vojvodina (according to the Provincial Secretariat for Education, Regulations, Administration and National Minorities – National Communities), we selected at least one school from each district, a total of ten schools (two gymnasiums and eight trade schools). In the second stage, one class from each year was randomly selected from each selected school. A total of 40 high school classes were included in the sample, and the expected number of respondents was around 1,000.

Ethical Clearance

The research protocol received approval from the Ethics Committee of the Medical Faculty University of Novi Sad. Participation in the study was voluntary, and participants were fully informed about the objectives and methods of the study. The entire development of the study followed the ethical recommendations outlined in the Declaration of Helsinki.

Study Participants

A total of 986 high-school students (47.4% girls and 52.6% boys; mean 16.6 years, SD ± 1.1 years) aged 15–19 years were recruited for this study. The research included students who were present at school on the day of the study. Students under 15 and over 19 years were excluded, as well as students who were exempted from physical education classes on the day of the research and seven days before and students who did not agree to participate in the research. Participants were categorized into four groups based on their year of study.

Data Collection

Anthropometric Measurements

Trained personnel recorded all anthropometric measurements, with the participants wearing light clothes and no shoes. Height was measured with an anthropometer (SECA) with the head positioned in the Frankfurt plane, and an electronic digital scale (SECA) was used to measure weight with accuracy ±0.1 kg. BMI was calculated as weight in kilograms (kg) divided by height in meters squared (m^2). The subject was defined as having a normal weight if their BMI-for-age value was $\geq \bar{x} - 2$ SD and $\leq \bar{x} + 1$ SD, malnourished if their BMI-for-age value was $< \bar{x} - 2$ SD, overweight if their BMI-for-age value was $> \bar{x} + 1$ SD and $\leq \bar{x} + 2$ SD, and as obese if their BMI-for-age value was $> \bar{x} + 2$ SD (7). Waist circumference was measured above the iliac crest and below the lowest rib margin at minimum respiration with an anthropometric measuring tape in a standing position. WHtR was calculated as waist circumference (cm) divided by height (cm), and abdominal obesity among adolescents was identified using a suggested WHtR cut-off of ≥ 0.5 (20). A WHtR of ≥ 0.5 was considered high risk, and adolescents with high-risk WHtR were considered to have abdominal obesity (21).

Demographic and Socioeconomic Characteristics

Socio-demographic data was collected using a questionnaire developed for this study. The age of each individual in the study was obtained using years and months of age. The self-reported questionnaire included the following data: the year of high-school study, number of family members, number of parents, community type, mother's education, father's education, employment status of the mother, employment status of the father and final evaluation of previous school year.

Table 1. *Characteristics of sample of adolescents in Vojvodina (N = 986)*

Variables	Gender			p-value
	Male n (%)	Female n (%)	Total n (%)	
Class				
First	146 (28.2)	131 (28.1)	277 (28.1)	0.173
Second	133 (25.7)	115 (24.6)	248 (25.2)	
Third	139 (26.8)	106 (22.7)	245 (24.9)	
Fourth	100 (19.3)	115 (24.6)	215 (21.8)	
Community type				
Rural	202 (39.0)	171 (36.6)	373 (37.9)	0.551
Suburban	61 (11.8)	50 (10.7)	111 (11.3)	
Urban	255 (49.2)	246 (52.7)	501 (50.9)	
High school				
Gymnasium	76 (14.6)	137 (29.3)	213 (21.6)	**< 0.001**
Trade school	443 (85.4)	330 (70.7)	773 (78.4)	
School success				
Excellent	115 (22.2)	226 (48.4)	341 (34.6)	–
Very good	251 (48.4)	170 (36.4)	421 (42.7)	
Good	137 (26.4)	67 (14.3)	204 (20.7)	
Sufficient	9 (1.7)	3 (0.6)	12 (1.2)	
Insufficient	7 (1.3)	0 (0.0)	7 (0.7)	
Repeating the class	0 (0.0)	1 (0.2)	1 (0.1)	
Number of family members				
2	29 (5.6)	28 (6.0)	57 (5.8)	0.667
3	104 (20.0)	86 (18.4)	190 (19.3)	
4	220 (42.4)	185 (39.6)	405 (41.1)	
5	106 (20.4)	102 (21.8)	208 (21.1)	
> 5	60 (11.6)	66 (14.1)	126 (12.8)	
Number of parents				
1	101 (19.5)	88 (18.9)	189 (19.2)	0.831
2	418 (80.5)	377 (81.1)	795 (80.8)	
Mother's education				
No/incomplete primary school	3 (0.6)	3 (0.6)	6 (0.6)	0.925
Primary school	46 (9.0)	36 (7.8)	82 (8.4)	
High school	283 (55.4)	268 (58.0)	551 (56.6)	
College	61 (11.9)	52 (11.3)	113 (11.6)	
University degree	118 (23.1)	103 (22.3)	221 (22.7)	
Father's education				
No/incomplete primary school	3 (0.6)	4 (0.9)	7 (0.7)	0.576
Primary school	46 (9.1)	40 (8.7)	86 (8.9)	
High school	325 (64.0)	290 (63.0)	615 (63.5)	
College	54 (10.6)	39 (8.5)	93 (9.6)	
University degree	80 (15.7)	87 (18.9)	167 (17.3)	

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Variables	Gender			p-value
	Male n (%)	Female n (%)	Total n (%)	
Mother's work status				
Employed	362 (70.3)	338 (73.8)	700 (71.9)	0.804
Self-employed	54 (10.5)	45 (9.8)	99 (10.2)	
Retiree	5 (1.0)	4 (0.9)	9 (0.9)	
Unemployed	82 (15.9)	62 (13.5)	144 (14.8)	
Not know	12 (2.3)	9 (2.0)	21 (2.2)	
Father's work status				
Employed	375 (74.0)	313 (68.2)	688 (71.2)	0.283
Self-employed	93 (18.3)	102 (22.2)	195 (20.2)	
Retiree	7 (1.4)	12 (2.6)	19 (2.0)	
Unemployed	26 (5.1)	25 (5.4)	51 (5.3)	
Not know	6 (1.2)	7 (1.5)	13 (1.3)	
Nutrition status				
Underweight	19 (3.7)	18 (3.9)	37 (3.8)	**< 0.001**
Normal weight	312 (60.1)	344 (73.7)	656 (66.5)	
Overweight	119 (22.9)	74 (15.8)	193 (19.6)	
Obese	69 (13.3)	31 (6.6)	100 (10.1)	
Waist-to-height ratio				
< 0.5	415 (80.0)	424 (90.8)	839 (85.1)	**< 0.001**
≥ 0.5	104 (20.0)	43 (9.2)	147 (14.9)	
Total	519 (100.0)	467 (100.0)	986 (100.0)	

Numbers in bold indicate statistically significant values.

Statistical Analysis

The primary database was transformed into a form suitable for processing using the statistical package SPSS 21 for Windows (IBM). Standard methods of descriptive and inferential statistics were used in the statistical analysis of the data. A significance level of $p < 0.05$ was considered statistically significant. To determine the association between obesity and socio-demographic factors, univariate and multivariate logistic regression models were implemented. We calculated the association through odds ratio (OR) with 95% confidence intervals (95% CI).

RESULTS

There were 986 respondents, 467 girls (47.4%) and 519 boys (52.6%). The demographic and socioeconomic characteristics of the adolescents, as well as the prevalence of overweight and obesity in the sample, are presented in Table 1. According to the z-score of BMI, 19.6% of adolescents were overweight, while 10.1% were obese. The obtained results have shown that there is a significant difference in nutrition level distribution in relation to gender. Among boys, 13.3% were obese and 22.9% were overweight, and among girls, 6.6% were obese, and 15.8% were overweight. A total of 14.9% of high school students had high-risk WHtR, a significantly higher number of boys than their counterpart girls.

The nutritional status showed statistically significant differences by the community type. High school students from the suburban and rural areas were more obese than those from the urban areas (13.5% and 12.9% vs. 7.4%, respectively), with a similar pattern among overweight adolescents. High school students from trade high schools were significantly more obese (12.2%) compared to those from gymnasiums (2.8%). The prevalence of obesity increased with a decrease in the level of parents' education (Table 2).

The association of socio-demographic characteristics with obesity was analysed using univariate and multivariate logistic regression (Table 3). Univariate logistic regression identified gender, school success, community type, type of high school, and father's education as significant predictors of obesity. In the multivariate model gender, community type, type of high school, and father's education proved to be statistically significant predictors. Boys were almost two times more likely to be obese than girls (OR = 1.87; 95% CI: 1.37–2.56). Students living in suburban areas had a greater chance of obesity compared to those living in urban areas (OR = 1.84; 95% CI: 1.15–2.94) and students who attended trade schools compared to gymnasium students (OR = 1.92; 95% CI: 1.20–3.07). Adolescents whose fathers are in the category with the lowest level of education had more than two times higher chance of obesity (OR = 2.42; 95% CI: 1.30–4.52) compared to those whose fathers were highly educated.

Table 2. *Nutrition status of adolescents in Vojvodina according to socioeconomic characteristics (N = 986)*

Variables	Nutrition status					p-value
	Underweight n (%)	Normal weight n (%)	Overweight n (%)	Obese n (%)	Total n (%)	
Class						
First	9 (3.2)	181 (65.3)	60 (21.7)	27 (9.7)	277 (100.0)	0.054
Second	14 (5.6)	155 (62.5)	51 (20.6)	28 (11.3)	248 (100.0)	
Third	7 (2.9)	174 (71.0)	33 (13.5)	31 (12.7)	245 (100.0)	
Fourth	7 (3.3)	146 (67.9)	49 (22.8)	13 (6.0)	215 (100.0)	
Community type						
Rural	11 (2.9)	239 (64.1)	75 (20.1)	48 (12.9)	373 (100.0)	**0.011**
Suburban	4 (3.6)	62 (55.9)	30 (27.0)	15 (13.5)	111 (100.0)	
Urban	22 (4.4)	354 (70.7)	88 (17.6)	37 (7.4)	501 (100.0)	
High school						
Gymnasium	4 (1.9)	173 (81.2)	30 (14.1)	6 (2.8)	213 (100.0)	**< 0.001**
Trade school	33 (4.3)	483 (62.5)	163 (21.1)	94 (12.2)	773 (100.0)	
Mother's education						
No primary school or incomplete primary school	9 (10.2)	47 (53.4)	22 (25.0)	10 (11.4)	88 (100.0)	**0.008**
High school	14 (2.5)	371 (67.3)	110 (20.0)	56 (10.2)	551 (100.0)	
College or university degree	14 (4.2)	231 (69.2)	56 (16.8)	33 (9.9)	334 (100.0)	
Father's education						
No primary school or incomplete primary school	3 (3.2)	51 (54.8)	24 (25.8)	15 (16.1)	93 (100.0)	**0.004**
High school	16 (2.6)	407 (66.2)	127 (20.7)	65 (10.6)	615 (100.0)	
College or university degree	15 (5.8)	187 (71.9)	40 (15.4)	18 (6.9)	260 (100.0)	
Mother's work status						
Employed	33 (4.1)	531 (66.5)	157 (19.6)	78 (9.8)	799 (100.0)	0.406
Unemployed	4 (2.6)	97 (63.4)	31 (20.3)	21 (13.7)	153 (100.0)	
Father's work status						
Employed	34 (3.9)	587 (66.5)	170 (19.3)	92 (10.4)	883 (100.0)	–
Unemployed	0 (0.0)	51 (72.9)	15 (21.4)	4 (5.7)	70 (100.0)	
Total	34 (3.6)	638 (66.9)	185 (19.4)	96 (10.1)	953 (100.0)	

Numbers in bold indicate statistically significant values.

The association between socio-demographic factors and WHtR ≥ 0.5 was analysed through univariate and multivariate logistic regression (Table 4). Predictors in the univariate analysis that statistically significantly contribute to high-risk WHtR are gender, age, school success, high school type, and mother's and father's education level. In the multivariate analysis, boys, compared to girls, had higher odds of having WHtR ≥ 0.5 (OR = 2.17; 95% CI: 1.39–3.38), students of trade schools than those from gymnasiums (OR = 5.52; 95% CI: 2.09–14.60). Adolescents whose fathers are in the category with the lowest level of education had almost three times a greater chance of high-risk WHtR compared to those whose fathers have the highest level of education (OR = 2.71; 95% CI: 1.23–6.01).

DISCUSSION

To the best of our knowledge, this is the most recent epidemiological study assessing the prevalence of overweight/obesity based on accurate anthropometric measurements and its association with socio-demographic factors conducted on a representative sample of adolescents in Vojvodina. Characteristics of nutritional status of 15–19 years old adolescents in Vojvodina according to BMI showed that 19.6% of adolescents were overweight, while 10.1% of adolescents were obese. It is worth mentioning that from 1999 to 2016 the combined prevalence of overweight and obesity increased in the Mediterranean region from 22.9% to 25.0% but no substantial changes were observed in Atlantic Europe or Central Europe, where the overweight and obesity prevalence in 2–13 years old children changed from 18.3% to 19.3% and from 15.8% to 15.3%, respectively (22). The COVID-19 pandemic also significantly influenced child and adolescent obesity around the world for many preventable reasons but hardly preventable in those circumstances (12, 13). A large China study from 2020 confirmed that during the COVID-19 lockdown the youths' average body mass index significantly increased from 21.8 to 22.1 kg/m^2, with the prevalence of overweight/obesity and obesity increasing from 21.4% to 24.6% and from 10.5% to

Table 3. *Odds ratios of obesity in adolescents in Vojvodina by socio-demographic characteristics (N = 986)*

Variables	Univariate logistic regression		Multivariate logistic regression	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Gender				
Female	1.00[a]		1.00[a]	
Male	1.95 (1.48–2.60)	**< 0.001**	1.87 (1.37–2.56)	**< 0.001**
Age	0.91 (0.81–1.04)	0.178	0.88 (0.76–1.00)	0.057
School success (1: repeating the class–6: excellent)	0.75 (0.63–0.88)	**0.001**	0.96 (0.79–1.18)	0.742
Community type				
Urban	1.00[a]		1.00[a]	
Suburban	2.05 (1.33–3.15)	**0.001**	1.84 (1.15–2.94)	**0.011**
Rural	1.48 (1.10–1.99)	**0.009**	1.17 (0.84–1.64)	0.349
High school				
Gymnasium	1.00[a]		1.00[a]	
Trade school	2.45 (1.66–3.61)	**< 0.001**	1.92 (1.20–3.07)	**0.006**
Number of parents				
2	1.00[a]		1.00[a]	
1	1.06 (0.75–1.51)	0.737	1.18 (0.76–1.82)	0.461
Number of family members	1.02 (0.89–1.16)	0.811	1.03 (0.88–1.19)	0.733
Mother's education				
College or university degree	1.00[a]		1.00[a]	
High school	1.19 (0.88–1.61)	0.268	0.80 (0.55–1.17)	0.252
Primary school or incomplete primary school	1.57 (0.95–2.59)	0.074	0.99 (0.53–1.85)	0.977
Father's education				
College or university degree	1.00[a]		1.00[a]	
High school	1.58 (1.23–2.22)	**0.008**	1.48 (0.98–2.24)	0.059
Primary school or incomplete primary school	2.51 (1.52–4.17)	**< 0.001**	2.42 (1.30–4.52)	**0.005**
Father's work status				
Unemployed	1.00[a]		1.00[a]	
Employed	1.13 (0.66–1.95)	0.655	1.46 (0.80–2.64)	0.216
Mother's work status				
Unemployed	1.00[a]		1.00[a]	
Employed	0.81 (0.56–1.17)	0.259	0.98 (0.65–1.46)	0.908

[a]Reference value; OR – odds ratio; CI – confidence interval. Numbers in bold indicate statistically significant values.

12.6%, respectively (14). In Serbia in 6–9 years old children, the combined rate of overweight and obesity was reported to be as high as 23%, with an obesity rate of 6.9%. Moreover, the study by Djordjic showed that the prevalence of overweight (including obesity) in Serbian 6–9 years old children ranged from 22.1% to 24.6% among boys and from 23.1% to 24.3% among girls (23). In the Health Behaviour in School-aged Children Survey in 2017 in Serbia based on the students' self-assessment of body height and weight, among 1st grade high school students, boys were more overweight (23.4% vs. 11.4%) and obese (11.0% vs. 4.2%) than girls (24). It is important to note that even if our data is from the COVID-19 pandemic period they may not be directly comparable to previous research in Serbia due to a lack of corresponding studies in the country. Our study results showed that the overweight and obesity combined rate of adolescents 15–19 years old in Vojvodina was 29.7%, 36.2% among boys, and 22.5% among girls.

In our research, consistent with other studies, boys were significantly more obese than girls (16, 23). According to our results, obesity affected 13.3% of boys and 6.6% of girls aged 15–19 years. Additionally, in our study sample, high-risk WHtR was found in 14.9% of adolescents in Vojvodina, with 20% of boys, and 9.2% of girls. Boys also had greater odds of abdominal obesity compared to girls. A Croatian study showed that abdominal obesity was also statistically higher in boys (25). On the other hand, a large American study showed that 34% of adolescents had high-risk WHtR (≥ 0.5) and girls had higher odds of high-risk WHtR compared to boys (OR = 1.46) (9). Many studies showed that in adolescents the cut-off value of WHtR at 0.5 provided good sensitivity and specificity for identifying metabolic syndrome in both

Table 4. *Odds ratios of high-risk waist-to-height ratio in adolescents in Vojvodina by socio-demographic characteristics (N = 986)*

Variables	Univariate logistic regression		Multivariate logistic regression	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Gender				
Female	1.00[a]		1.00[a]	
Male	2.21 (1.47–3.31)	**<0.001**	2.17 (1.39–3.38)	**0.001**
Age	1.15 (0.97–1.38)	0.111	1.14 (0.93–1.36)	0.192
School success (1: repeating the class–6: excellent)	0.65 (0.53–0.81)	**<0.001**	0.84(0.65–1.10)	0.207
Community type				
Urban	1.00[a]		1.00[a]	
Suburban	1.71 (0.95–3.06)	0.071	1.36 (0.71–2.62)	0.353
Rural	1.49 (0.99–2.25)	0.054	1.04 (0.66–1.64)	0.873
High school				
Gymnasium	1.00[a]		1.00[a]	
Trade school	7.49 (3.02–18.58)	**<0.001**	5.52 (2.09–14.60)	**0.001**
Number of parents				
2	1.00[a]		1.00[a]	
1	0.86 (0.52–1.41)	0.551	0.70 (0.38–1.30)	0.257
Number of family members	1.02 (0.85–1.22)	0.817	0.99 (0.80–1.22)	0.944
Mother's education				
College or university degree	1.00[a]		1.00[a]	
High school	1.13 (0.73–1.73)	0.658	0.68 (0.40–1.16)	0.157
Primary school or incomplete primary school	2.13 (1.14–3.97)	**0.017**	0.98 (0.45–2.17)	0.968
Father's education				
College or university degree	1.00[a]		1.00[a]	
High school	1.30 (0.80–2.12)	0.285	1.18 (0.65–2.12)	0.584
Primary school or incomplete primary school	3.42 (1.83–6.40)	**<0.001**	2.71 (1.23–6.01)	**0.014**
Father's work status				
Unemployed	1.00[a]		1.00[a]	
Employed	1.28 (0.57–2.87)	0.547	1.58 (0.68–3.71)	0.290
Mother's work status				
Unemployed	1.00[a]		1.00[a]	
Employed	0.73 (0.45–1.19)	0.211	0.87 (0.51–1.49)	0.619

[a]Reference value; OR – odds ratio; CI – cofidence interval. Numbers in bold indicate statistically significant values.

genders and indicated a greater risk for death before the age of 55 years (8, 26). Although boys in Vojvodina are more abdominally obese, the health promotion policy should focus on both sexes, taking into account potential future cardiometabolic problems.

The prevalence of obesity is influenced by various factors, including gender, ethnicity, socioeconomic status, and parents' level of education (5, 27). In our study, the association between socio-demographic factors and abdominal obesity and BMI was not consistent. Even though adolescents from suburban areas had greater odds of obesity compared to those living in urban areas, no association between community type and higher WHtR was found. This could be associated with sedentary activity, which could be lower in rural areas, so it needs further investigation. In the United States, adolescents living in rural environment had a greater chance of being obese than those living in urban areas, the obesity rate was higher among rural children than urban children (OR = 1.26) (28). However, another study, in addition to the division into urban and rural areas, including suburban ones, showed no differences in BMI percentiles concerning rurality, although suburban status was significantly associated with several diet-related risk factors (29). On the contrary, data from a cross-sectional, nationally representative survey in Indonesia showed that the prevalence of overweight and obesity among children and adolescents was higher in urban areas (17%) than in rural areas (13.5%), and in a multivariate logistic regression model analysis, after controlling for all variables, children and adolescents living in urban areas were all significantly associated with a higher risk of overweight and obesity (30). Differences in childhood and adolescence obesity prevalence by the level of urbanization which were reported by

many studies (28–31) should be recognized by practitioners and policymakers in every country.

The results of Seum et al. showed that prevention measures should be particularly targeted at children and adolescents of parents with low levels of education to address the significant public health challenge of increased BMI (32). In our study, logistic regression identified the father's education as a predictor for both obesity and abdominal obesity. A study by Ogden et al. on a population of children and adolescents aged 2–19 years, confirmed that the prevalence of obesity decreased as the head of household's level of education increased but the association is complex and differs by sex, race, and ethnicity (33). Also, similar associations were seen between parental education level and high-risk WHtR, as well as between household income and high-risk WHtR (9). These findings suggest that the father's level of education is directly linked to household income and impacts adolescent obesity and high-risk WHtR. Our results showed that adolescents with fathers in the lowest education category had more than double the likelihood of obesity. No association has been found between parents' work status and obesity or high-risk WHtR.

Furthermore, in our sample, the type of high school was a predictor for obesity and abdominal obesity in both regression models. High-school students from trade schools have higher odds of obesity (OR = 1.92) and abdominal obesity (OR = 5.52) than gymnasium students. In our sample, there were more boys than girls in trade schools, and the opposite in gymnasiums (more girls than boys) which could be one of the reasons for these results. Considering the above data, programmes for reducing obesity in adolescents should be focused on trade schools.

The results of this study could be the base for improving health behaviours and decreasing overweight and obesity in adolescents in Serbia. This study could also help to customize health promotion policies for adolescents. The most important advantage of this study is the method and accurate anthropometric measurements; body height, body weight, and waist circumference were measured instead of using self-reported data.

CONCLUSION

The prevalence of obesity and overweight in adolescents in Vojvodina aligns with trends in other European regions. Almost one in three 15–19 years old boys and one in five 15–19 years old girls in Vojvodina are overweight or obese. Abdominal obesity is highly present among high-school students in the region. Gender, community type, and the level of the father's education were identified as factors that influenced both obesity and abdominal obesity. This study provides valuable insights for tailoring health promotion policies for adolescents in Serbia.

Conflicts of Interest

None declared

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