

Original article

Prevalence of obesity among final-year high school students in Doboj

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Summary

Introduction. Adolescent obesity is a growing public health challenge with long-term cardiometabolic consequences. This study aimed to determine the prevalence of general and abdominal obesity among final-year high school students in Doboj and to identify key risk factors.

Methods. A cross-sectional study was conducted on a sample of 1820 final-year high school students in Doboj. Nutritional status was assessed using Body Mass Index and the waist-to-height ratio. Data on lifestyle habits were collected via a survey questionnaire, and risk factors were analyzed using multivariate logistic regression.

Results. The prevalence of general obesity was 4.7%, while abdominal obesity (WHtR ≥ 0.5) was identified in as many as 21.6% of the participants. Multivariate logistic regression identified four independent predictors: male sex (OR = 2.41, 95% CI: 1.52–3.82, $p < 0.001$), skipping breakfast (OR = 2.08, 95% CI: 1.02–4.25, $p = 0.045$), not consuming snacks (OR = 2.25, 95% CI: 1.44–3.51, $p < 0.001$), and “fairly good” material status (OR = 2.47, 95% CI: 1.36–4.49, $p = 0.003$). Physical activity was not identified as a statistically significant independent predictor ($p = 0.132$).

Conclusion. Although the prevalence of general obesity is low, the high rate of abdominal obesity (21.6%) indicates a need for including WHtR in routine school screenings to identify “hidden” metabolic risks.

Key words: obesity, adolescents, WHtR, nutritional status

Introduction

Obesity in children and adolescents represents one of the most serious public health challenges of the 21st century, taking on the characteristics of a global pandemic affecting both developed

and developing societies [1]. It is defined as the excessive accumulation of body fat leading to an increase in body weight above reference values for age, sex, and height, carrying serious short-term and long-term health implications [2]. Although Body Mass Index is the most commonly used indicator for assessing obesity, the modern scientific community increasingly highlights its limitations, particularly regarding its inability to distinguish fat tissue from muscle mass and the lack of information on fat distribution [3, 4].

While numerous studies have analyzed the correlation among dietary habits, physical activity, and obesity, most data originate from developed countries, while data for regional countries, including Bosnia and Herzegovina, remain limited [5, 6]. Local dietary patterns, socioeconomic factors, and lifestyle can significantly influence the development of adolescent obesity [7, 8]. Previous research indicates that skipping breakfast, irregular eating habits, low fruit and vegetable intake, and insufficient physical activity represent key risk factors for obesity development [9, 10].

The aim of this research was to estimate the prevalence of obesity among final-year high school students in the Doboj region and its association with dietary habits and physical activity levels. Based on this, it was hypothesized that obesity is significantly associated with irregular dietary habits and insufficient physical activity.

Methods

The research was designed as a cross-sectional study conducted among final-year students of all high schools in the Doboj region. The sample included 1820 participants who were 18 years old at the time of the study and provided voluntary written consent. The study was approved by the Ethics Committee of the “St. Apostle Luka” General Hospital in Doboj.

The primary research instrument was the

World Health Organization questionnaire “HBSC Study Protocol 2013–2014,” supplemented with specific questions created for the needs of this study [11]. Anthropometric measurements were conducted in the morning using calibrated equipment: a “Seca 206” portable stadiometer (precision 0.1 cm), “Seca” scales, and “Seca 201” flexible tape. Waist circumference was measured midway between the lower rib margin and the upper iliac crest, following international standards for cardiometabolic risk assessment [12]. Nutritional status was classified using BMI z-scores according to recommendations allowing for more precise categorization of nutritional status in adolescents [13]. Central obesity was assessed using the waist-to-height ratio, with a threshold of ≥ 0.5 used as a reliable indicator of elevated health risk [14, 15]. This methodology aligns with modern recommendations (including NICE 2022) suggesting that WHtR is a more sensitive indicator of abdominal obesity in youth compared to BMI alone [4, 13]. Statistical data processing was performed using SPSS version 22.0 software. Analysis included descriptive statistics and inferential methods. Differences between categorical variables were tested using the chi-square (χ^2) test, while multivariate logistic regression was used to identify independent predictors of obesity, with a significance level of $p < 0.05$.

Results

The investigation of obesity prevalence was conducted among final-year high school students in the Doboj region. General obesity was identified in 4.7% (86/1820) of the participants. Among the obese subjects, males were significantly more represented (67.4% (58/86)) compared to females (32.6% (28/86)) ($\chi^2=1.394$; $df=1$; $p=0.001$). The strength of the association between sex and obesity, expressed by Cramer’s V coefficient of 0.082, indicated a small but stable effect.

Table 1. Nutritional status according to sex structure

Nutritional Status	Male N (%)	Female N (%)	Total N (%)
Normal weight	801 (46.2)	933 (53.8)	1734 (95.3)
Obese	58 (67.4)	28 (32.6)	86 (4.7)
Total	859 (47.2)	961 (52.8)	1820 (100)

Analysis of abdominal obesity revealed an overall prevalence of 21.6% (394/1820), with the frequency being evenly distributed between sexes. No statistically significant difference was found in the frequency of ab-

dominal obesity between males and females ($\chi^2=0.051$; $df=1$; $p=0.823$). The Cramer's V value (0.005) indicated a negligible association between sex and this type of obesity.

Table 2. Frequency of abdominal obesity according to sex structure

Abdominal Obesity	Male N (%)	Female N (%)	Total N (%)
No	675 (47.3)	751 (52.7)	1426 (78.4)
Yes	184 (46.7)	210 (53.3)	394 (21.6)
Total	859 (47.2)	961 (52.8)	1820 (100)

Note: Abdominal obesity is defined as waist-to-height ratio ≥ 0.5 , a recognized international threshold for predicting cardiometabolic risk in adolescents

When analyzing the type of obesity in relation to sex, no statistically significant difference was found between male and female participants (χ^2 test = 2.35; $df=1$; $p=0.125$). The

Cramer's V coefficient of 0.07 indicated a very low intensity of association between sex and obesity type in the examined sample.

Table 3. Frequency of general and abdominal obesity in relation to sex

Type of Obesity	Male N (%)	Female N (%)	Total N (%)
Abdominal obesity	184 (46.7)	210 (53.3)	394 (100)
General obesity	58 (67.4)	28 (32.6)	86 (100)
Total	242 (50.4)	238 (49.6)	480 (100)

Regarding dietary habits, 77.3% of normal weight and 68.6% of obese students consume breakfast daily on weekdays, while these percentages are higher during weekends (82.6% for normal weight and 75.6% for obese). Although obese students are twice as likely to skip breakfast entirely on weekdays (9.3% vs.

5.1%), bivariate analysis showed no statistically significant difference for either the weekdays ($\chi^2=2.98$; $df=1$; $p=0.084$) or the weekend ($\chi^2=1.83$; $df=1$; $p=0.176$), with low association coefficients ($V \leq 0.04$). Overall, 76.9% of students practice daily breakfast on weekdays, and 82.3% on weekends.

Table 4. Breakfast habits (weekdays and weekends)

Breakfast Habit	Normal weight N (%)	Obese N (%)	Total N (%)
Daily breakfast (weekdays)	1341 (77.3)	59 (68.6)	1400 (76.9)
No breakfast (weekdays)	88 (5.1)	8 (9.3)	96 (5.3)
Breakfast (both weekend days)	1432 (82.6)	65 (75.6)	1497 (82.3)
No breakfast (weekends)	103 (5.9)	8 (9.3)	111 (6.1)

A highly significant difference was found in the frequency of snack consumption according to nutritional status ($\chi^2=13.79$; $df=1$; $p=0.001$). Regular snacking is practiced by 74.0% of normal weight compared to 55.8% of obese students, while skipping this meal entirely is nearly twice as frequent among the

obese (44.2%) compared to normal weight students (26.0%). Although fruit dominates as the primary choice in both groups (48–53%), cake consumption as a snack is three times more common among normal weight students (5.9%) than among the obese (2.0%).

Table 5. Frequency of snack consumption in relation to nutritional status (choice of snack)

Snack Consumption	Normal weight N (%)	Obese N (%)	Total N (%)
Consumes snacks	1283 (74.0)	48 (55.8)	1331 (73.1)
Does not consume	451 (26.0)	38 (44.2)	489 (26.9)
Fruit as a snack	637 (48.3)	27 (52.9)	664 (48.3)
Cake as a snack	78 (5.9)	1 (2.0)	79 (5.7)

Note: Percentages for fruit/cake consumption are calculated only for the sub-sample of students who reported regular snack consumption ($N=1331/1820$).

Analysis of physical activity in relation to nutritional status showed no statistically significant association ($\chi^2=2.27$; $df=1$; $p=0.132$).

The Cramer's V coefficient of 0.035 indicated a very weak association.

Table 6. Frequency of physical activity (at least 60 min daily) in relation to nutritional status

Activity Level	Normal weight N (%)	Obese N (%)	Total N (%)
Active (3–7 days)	990 (94.6)	56 (5.4)	1046 (100)
Inactive (0–2 days)	744 (96.1)	30 (3.9)	774 (100)
Total	1734 (95.3)	86 (4.7)	1820 (100)

The majority of participants (85.5%) assess their family's material status as average. However, a "fairly good" status is twice as

frequent among obese students (17.4%) compared to their normal weight peers (7.7%).

Table 7. Family material status in relation to nutritional status

Obesity	Very Good N (%)	Fairly Good N (%)	Average N (%)	Not So Good N (%)	Not Good N (%)	Total N (%)
No	67 (3.9)	133 (7.7)	1489 (85.9)	42 (2.4)	3 (0.2)	1734 (100)
Yes	1 (1.2)	15 (17.4)	68 (79.1)	2 (2.3)	0 (0.0)	86 (100)
Total	68 (3.7)	148 (8.1)	1557 (85.5)	44 (2.4)	3 (0.2)	1820 (100)

Self-reported subjective assessment; 'fairly good' reflects the participant's perception of their household's economic standing.

Multivariate logistic regression identified four independent predictors of obesity. The strongest influence was male sex (OR = 2.41; 95% CI: 1.52–3.82; $p < 0.001$). Among dietary habits, skipping breakfast significantly increased the odds of obesity (OR = 2.08; 95% CI: 1.02–4.25; $p = 0.045$), while students not consuming snacks had a 2.25 times higher risk (OR = 2.25; 95% CI: 1.44–3.51; $p < 0.001$).

Additionally, final-year students with a 'fairly good' material status were 2.47 times more likely to be obese compared to those with an average status (OR = 2.47; 95% CI: 1.36–4.49; $p = 0.003$). Physical activity (0–2 days) was not identified as a statistically significant independent predictor in this model (OR = 0.71; $p = 0.132$).

Table 8. Logistic regression of obesity predictors

Predictor	*OR	*95% CI	p-value
Sex	2.41	1.52–3.82	< 0.001
Skipping breakfast	2.08	1.02–4.25	0.045
Not consuming snacks	2.25	1.44–3.51	< 0.001
Material status: fairly good	2.47	1.36–4.49	0.003
Physical activity (0–2 days)	0.71	0.46–1.11	0.132
*OR - Odds Ratio; CI - Confidence Interval			

Discussion

At a global level, an alarming increase in the prevalence of obesity is recorded, as indicated by recent studies on risk factors for chronic non-communicable diseases [4]. Overweight during the adolescent period is directly linked to cardiovascular, endocrine, musculoskeletal, and digestive complications, which is confirmed by systematic literature reviews [5]. The

results of our study provide a detailed insight into these trends among high school final-year students in Dobož. The total obesity prevalence of 4.7% (86/1820) is significantly lower compared to research conducted in Vojvodina, where a substantially higher rate of 10.1% was recorded among adolescents. One of the most significant findings of our study is the identification of the male sex as the strongest predictor of obesity (OR = 2.41). This trend is

fully consistent with findings from Vojvodina, where prevalence among boys was 13.3% and 6.6% among girls [1]. Although the male sex was the significant predictor with a risk of 1.87 in the Vojvodina sample, the influence of sex on nutritional status is even more pronounced in our sample [1, 6]. Studies from 2024 confirm that the male sex remains the dominant socio-demographic predictor of obesity and overweight in the region [7].

Abdominal obesity (WHtR ≥ 0.5) was recorded in more than one-fifth of the participants (21.6% /394/1820), and results show that this cardiometabolic risk is evenly distributed between sexes [2, 8]. This finding deviates from trends in Vojvodina, where abdominal obesity was significantly higher in boys [1]. The fact that every fifth girl in Doboj (21.8%) has an elevated waist-to-height ratio, despite a low general obesity rate, points to the presence of so-called “hidden obesity.” This aligns with the findings of the German KiGGS study, which emphasizes that the WHtR threshold of 0.5 identifies risk in adolescents who might otherwise be overlooked by standard BMI measurements [3, 9].

The significance of snacking as a protective factor was particularly highlighted; not consuming snacks increases the risk of obesity by 2.25 times. Our bivariate analysis confirmed that obese students skipped snacks at a significantly higher percentage (44.2%) compared to their normal weight peers (26.0%). These findings support the theory that meal frequency is crucial for maintaining energy balance and preventing metabolic disorders [10–12].

Similar patterns of irregular nutrition have been recorded among adolescents in Mostar and other parts of the Balkans [12, 13]. Finally, the absence of a statistically significant correlation between the frequency of physical activity and obesity ($p = 0.132$) suggests that adolescents in Doboj primarily regulate their body mass through other behavioral patterns or that the intensity of activity is insufficient [14, 15]. Similar studies in the region empha-

size that physical activity is often suppressed by the dominant influence of dietary habits and sex [1, 13]. The latest data from 2024 indicate a continued trend of increasing obesity among adolescents, with HBSC research results showing high prevalence rates in the region, consistent with our warnings regarding the need for early risk identification [16, 17].

A low rate of activity (up to two days per week) in part of the sample correlates with a sedentary lifestyle that dominates the modern environment. Lack of a statistically significant association between physical activity and obesity ($p = 0.132$) may be attributed to self-reporting bias or the dominant influence of dietary patterns in this sample. This aligns with findings from the Spanish AN-IBES study, where specific lifestyle patterns involving meal frequency and dietary choices were stronger predictors of weight status than physical activity levels alone [18, 19]. Our results emphasize that skipping breakfast and snacks significantly disrupts energy balance, leading to a higher BMI, a trend also noted in other regional studies [13, 7].

Study limitations

This study has several limitations. Due to its cross-sectional design, causal relationships cannot be established. Dietary habits and physical activity are self-reported and may be affected by social desirability bias. The study covered adolescents from a single geographic region, which limits the generalization of findings to the entire national population. Additionally, the relatively small number of obese participants may have affected the statistical power of the study.

Conclusion

The study confirms a general obesity prevalence of 4.7% (86/1820), while simultaneously

revealing an alarmingly high rate of abdominal obesity at 21.6% (394/1820), which affects both sexes equally (46.7% boys and 53.3% girls; $p = 0.823$). These findings clearly point to the phenomenon of 'hidden obesity,' where a significant number of adolescents with metabolic risk remain unrecognized when BMI criteria are used exclusively. Multivariate analysis identified key independent predictors: male sex (OR = 2.41), irregular breakfast (OR = 2.08), skipping snacks (OR = 2.25), and 'fairly good' material status (OR = 2.47). Given that

BMI is not a sufficiently sensitive indicator for all forms of metabolic risk, the mandatory implementation of a WHtR threshold of 0.5 in routine school screenings is strongly recommended for the early detection of abdominal adiposity and the identification of at-risk individuals. Finally, the development of targeted educational programs in high schools, with a specific focus on the importance of meal regularity as a key factor in energy balance, represents an essential strategy for modifying risk factors in this population.

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Ethical approval. The Ethics Committee of the General Hospital "St. Apostle Luka", Dobož, Republic of Srpska, Bosnia and Herzegovina, approved the protocol and informed

voluntary consent was obtained from all individual respondents and non decline to participate. The research was conducted according to the Declaration of Helsinki.

Conflicts of interest. The authors declare no conflict of interest.

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Učestalost gojaznosti kod učenika završnih razreda srednjih škola u Doboju

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Uvod. Gojaznost adolescenata predstavlja sve veći javnozdravstveni problem sa dugoročnim kardiometaboličkim posljedicama. Cilj ovog istraživanja bio je da se utvrdi prevalencija opšte i abdominalne gojaznosti među učenicima završnih razreda srednjih škola u Doboju, kao i da se identifikuju ključni faktori rizika.

Metode. Sprovedeno je studijsko istraživanje presjeka na uzorku od 1820 učenika završnih razreda srednjih škola u Doboju. Nutritivni status procijenjen je primjenom indeksa tjelesne mase (Body Mass Index - BMI) i odnosa obima struka i tjelesne visine (waist-to-height ratio - WHtR). Podaci o životnim navikama prikupljeni su pomoću anketnog upitnika, a faktori rizika analizirani su primjenom multivarijantne logističke regresije.

Rezultati. Prevalencija opšte gojaznosti iznosila je 4,7%, dok je abdominalna gojaznost ($WHtR \geq 0,5$) utvrđena kod čak 21,6% ispitanika. Multivarijantna logistička regresija identifikovala je četiri nezavisna prediktora: muški pol ($OR = 2,41$; 95% CI: 1,52–3,82; $p < 0,001$), preskakanje doručka ($OR = 2,08$; 95% CI: 1,02–4,25; $p = 0,045$), nekonzumiranje užine ($OR = 2,25$; 95% CI: 1,44–3,51; $p < 0,001$) i „prilično dobar“ materijalni status ($OR = 2,47$; 95% CI: 1,36–4,49; $p = 0,003$). Fizička aktivnost nije identifikovana kao statistički značajan nezavisni prediktor ($p = 0,132$).

Zaključak. Iako je prevalencija opšte gojaznosti niska, visoka učestalost abdominalne gojaznosti (21,6%) ukazuje na potrebu uključivanja WHtR-a u rutinske školske skrining preglede radi identifikacije „skrivenih“ metaboličkih rizika.

Ključne riječi: gojaznost, adolescenti, WHtR, nutritivni status