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Health promotion

Anthropometric Status, Lifestyle Habits, and Foot Posture Findings among Primary Schoolchildren in Mostar, Bosnia and Herzegovina: A Regional Cross-Sectional Study

IGOR MASLAĆ[1], MARIN PULJIĆ[1], DAJANA VLADIĆ[2], BORIS OPANČAR[3], MARKO KLJAKIĆ[4], BENJAMIN PALIĆ[5,6]
[11] Department of Family Medicine, Health Center Mostar, Mostar, Bosnia and Herzegovina;[2] Department of Reanimation and Intensive Care, Health Center Mostar, Mostar, Bosnia and Herzegovina; [3] Department of Surgery, Vascular Surgery, University Clinical Hospital Mostar, Mostar, Bosnia and Herzegovina; [4] Department of Surgery, Plastic and Reconstructive Surgery, University Clinical Hospital Mostar, Mostar, Bosnia and Herzegovina; [5] Department of Internal Medicine, County Hospital Čakovec, Čakovec, Croatia; [6] Department of Pathophysiology, School of Medicine, University of Mostar, Mostar, Bosnia and Herzegovina

Keywords

Children • BMI-for-age • Waist circumference • Dietary habits • Screen time • Physical activity • Foot posture • School health

Summary

Introduction. *Childhood lifestyle habits and anthropometric status are markers of future cardiometabolic and musculoskeletal risk, but regional data from Bosnia and Herzegovina are limited. This study examined associations of excess body weight and waist circumference with lifestyle habits and foot posture findings among fifth- and seventh-grade schoolchildren from the Mostar region.*

Methods. *This cross-sectional study included 404 pupils attending routine school health examinations at the Mostar Health Center between September 2024 and May 2025. Data were collected using a structured questionnaire and standardized anthropometry. Nutritional status was classified according to WHO BMI-for-age criteria. Multivariable regression models assessed factors associated with excess body weight, waist circumference, and foot posture abnormalities.*

Results. *Excess body weight was present in 113 of 401 children (28.2%). Screen time ≥3 h/day was not associated with excess body weight (OR=0.71; 95% CI: 0.39-1.29; p=0.261) or waist circumference (B=-0.89; 95% CI: -3.01 to 1.24; p=0.413). Daily breakfast consumption was associated with lower odds of excess body weight (OR=0.42; 95% CI: 0.26-0.69; p=0.001), as was female sex (OR=0.45; 95% CI: 0.27-0.73; p=0.002). Fruit consumption was not significant (p=0.052). Foot posture abnormalities were associated with low physical activity and urban residence, but not with excess body weight or waist circumference.*

Conclusions. *Excess body weight was common. Breakfast consumption showed the most consistent favorable association with anthropometric status, while foot posture findings were related to physical activity and residence. These findings support school health strategies addressing nutrition and movement-related behaviors.*

Introduction

Childhood lifestyle habits are important determinants of later cardiometabolic health. Physical inactivity, excessive recreational screen time, and suboptimal dietary patterns may begin early in life and persist into adolescence and adulthood. This is clinically relevant because school age is a sensitive period for the development of daily routines related to movement, eating, and sedentary behavior. Data from the World Health Organization (WHO) European Childhood Obesity Surveillance Initiative (COSI) show substantial levels of insufficient physical activity and excessive screen time among children aged 6-9 years across European countries [1]. These patterns support the need to monitor lifestyle habits before adverse anthropometric and cardiometabolic consequences become established.

Anthropometric assessment is a central component of child health surveillance. Body mass index-for-age is widely used to classify nutritional status in school-aged children, while waist circumference provides additional information on central adiposity [2]. These indicators are not interchangeable because BMI reflects relative body mass, whereas waist circumference better captures abdominal fat distribution. This distinction is clinically relevant because childhood overweight and obesity are associated with cardiometabolic risk factors, including insulin resistance, dyslipidemia, elevated blood pressure, and later obesity-related morbidity [3]. Therefore, studies that examine both BMI-for-age categories and waist circumference can provide a more complete picture of anthropometric risk in children.

Children's lifestyle habits are shaped by family, socioeconomic, and environmental conditions. Dietary routines, physical activity, outdoor play, and screen exposure do not depend only on individual choice. They are also influenced by parental routines, household resources, neighborhood safety, traffic exposure, and access to spaces that support active play. Recent systematic reviews show that children and adolescents

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from lower socioeconomic backgrounds are more likely to have unfavorable health behaviors, including poorer diet quality, lower physical activity, and greater sedentary behavior [4, 5]. Built-environment features may further reinforce these inequalities by shaping children's daily opportunities for movement and healthy routines. These findings indicate that anthropometric risk should be interpreted together with the behavioral and environmental context in which children live.

Place-specific monitoring is needed to translate behavioral and environmental risks into practical prevention. Schools and school health services are particularly suitable for this purpose because they reach large numbers of children during a critical developmental period. Routine school health examinations allow standardized monitoring of growth, weight status, lifestyle habits, and selected clinical findings. COSI has demonstrated the value of standardized school-based monitoring of childhood obesity and related behaviors across countries [6]. Recent surveillance literature also emphasizes that better monitoring of physical activity and sedentary behavior can directly inform public health priorities and intervention planning [7]. In settings where national surveillance data are limited, school health services can provide important regional evidence for targeted prevention.

Evidence on lifestyle habits and anthropometric status among schoolchildren in Bosnia and Herzegovina remains limited. Recent standardized evidence from Bosnia and Herzegovina includes a pilot implementation of the COSI methodology in the Republic of Srpska, which examined overweight and obesity among primary-school children using standardized procedures [8]. Evidence from neighboring Croatia has also shown insufficient physical activity and unfavorable movement-related behaviors among children and adolescents [9]. However, few studies from Bosnia and Herzegovina have jointly examined BMI-for-age status, waist circumference, dietary habits, recreational screen time, physical activity, outdoor play and foot posture abnormalities in primary school children. This gap limits the ability to design locally relevant school health interventions.

Foot posture abnormalities may represent an additional clinical marker in routine child health assessment. Excess body weight can increase mechanical loading on the feet, while low physical activity may contribute to poorer musculoskeletal function and altered foot posture. Recent studies and reviews suggest that pediatric flatfoot is associated with elevated BMI, insufficient physical activity, and urban residence, although diagnostic criteria and measurement approaches vary across studies [10, 11]. Foot posture findings are therefore relevant in school health examinations because anthropometric and musculoskeletal screening often occur during the same preventive visit. Examining foot posture together with BMI-for-age, waist circumference, and lifestyle habits may broaden the understanding of child health beyond weight status alone.

To address this gap, this study examined anthropometric status, lifestyle habits, and foot posture abnormalities among fifth- and seventh-grade schoolchildren from the Mostar region. The primary aim was to examine the distribution of BMI-for-age categories and to assess whether excess body weight was associated with recreational screen time, physical activity, outdoor play, dietary habits, sex, grade, and urban/rural residence. Secondary aims were to analyze waist circumference as a continuous anthropometric outcome and to assess whether excess body weight and waist circumference were associated with foot posture abnormalities. By combining anthropometric, behavioral, environmental, and clinical foot data, this study provides regional evidence from routine school health examinations in Bosnia and Herzegovina.

Materials and Methods

Study Design and Setting

This regional cross-sectional study examined anthropometric status, lifestyle habits, and foot posture findings among fifth- and seventh-grade primary schoolchildren from the Mostar region, Bosnia and Herzegovina. The study was conducted between September 2024 and May 2025 at the Mostar Health Center, which provides primary healthcare services for the City of Mostar and surrounding settlements.

The study was embedded within routine systematic school health examinations conducted as part of the preventive school health program in primary care. These examinations include anthropometric assessment and evaluation of lifestyle-related health factors. Because participation was linked to routine preventive examinations rather than illness-related visits, the sample may be regarded as a regional school-based sample rather than a clinical sample. However, it should not be interpreted as nationally representative.

Participants

The sampling frame consisted of fifth- and seventh-grade pupils scheduled for routine systematic school health examinations during the study period. Participants were recruited consecutively during these examinations. All pupils attending the examination and meeting the eligibility criteria were invited to participate.

The inclusion criteria were: (1) attendance in the fifth or seventh grade of primary school; (2) scheduled attendance for a routine systematic school health examination during the study period; (3) residence in the Mostar Health Center catchment area; and (4) written informed consent provided by a parent or legal guardian. The exclusion criteria were: (1) absence from the scheduled examination; (2) lack of parental or legal guardian consent; and (3) incomplete key questionnaire or anthropometric data for analyses in which those variables were required.

During the study period, 413 pupils were scheduled for examination. Nine pupils were absent because of acute illness and did not attend the scheduled visit. The final study sample comprised 404 pupils.

Sample size calculation

The minimum required sample size was calculated using the single-population proportion formula for cross-sectional studies: $n=Z^2p(1-p)/d^2$. Assuming a 95% confidence level, a 5% margin of error, and an expected proportion of 50% for the most conservative estimate, the minimum sample size was 384 pupils. After allowing for possible non-attendance and incomplete data, the target sample was increased to approximately 404 pupils. A total of 413 pupils were scheduled, and 404 were included in the final sample.

Before analysis, participants were classified according to grade level (fifth *vs*. seventh grade) and place of residence (urban *vs*. rural). Place of residence was classified administratively according to the registered home address of each pupil. Urban residence was defined as residence within the administrative boundaries of the City of Mostar, characterized by higher population density and developed urban infrastructure. Rural residence included surrounding villages and settlements outside the urban administrative area, characterized by lower population density and predominantly rural land use.

Questionnaire and Lifestyle Variables

Data were collected using a structured questionnaire administered during routine school health examinations. The questionnaire was adapted from established child health surveillance items, including items used in the World Health Organization Childhood Obesity Surveillance Initiative.

Sociodemographic variables included age, sex, grade, and place of residence. Dietary variables included meal frequency, breakfast consumption, snacking, and frequency of intake of selected food groups and beverages. Movement-related variables included recreational screen time, physical activity outside school, and time spent in outdoor play.

The questionnaire was piloted in 30 pupils to assess clarity, comprehension, and completion time. Although the questionnaire was adapted from established surveillance instruments, it was not formally validated as an independent standalone instrument in the primary school population of Bosnia and Herzegovina. Therefore, self-reported behavioral data should be interpreted with appropriate caution.

For analysis, selected lifestyle variables were dichotomized to identify less favorable behavioral patterns and to ensure adequate group sizes for multivariable modeling. Recreational screen time was recorded as less than 1 hour/day, 1-3 hours/day, 3-5 hours/day, or more than 5 hours/day, and was dichotomized as <3 hours/day versus ≥3 hours/day. Physical activity outside school was recorded as less than 1 hour/day, 1-2 hours/day, or more than 2 hours/day, and low physical activity was defined as <1 hour/day. Outdoor play was analyzed as <1 hour/day versus ≥1 hour/day.

Dietary variables were analyzed using clinically interpretable categories. Daily breakfast consumption was defined as eating breakfast every day. Daily fruit consumption, daily vegetable consumption, and daily sweets consumption were defined according to reported daily intake. Frequent fast-food intake was defined as consumption several times per week or more. Carbonated drink consumption was analyzed as a binary variable based on reported intake.

Anthropometric Measurements and Nutritional Status

Anthropometric measurements were obtained according to standardized procedures for children and adolescents. Body weight was measured using a calibrated digital scale (Seca 803, Seca GmbH & Co. KG, Hamburg, Germany), and body height was measured using a portable stadiometer (Seca 213, Seca GmbH & Co. KG, Hamburg, Germany). Waist circumference was measured using a standard anthropometric technique. All measurements were performed during the same examination visit by trained healthcare personnel with experience in anthropometric assessment.

Body mass index was calculated as weight in kilograms divided by height in meters squared. Nutritional status was classified using age- and sex-specific World Health Organization BMI-for-age growth reference criteria for children and adolescents aged 5-19 years. Thinness was defined as BMI-for-age z-score <-2 SD, normal weight as BMI-for-age z-score ≥-2 SD and ≤+1 SD, overweight as BMI-for-age z-score >+1 SD and ≤+2 SD, and obesity as BMI-for-age z-score >+2 SD.

For regression analyses, overweight and obesity were combined into a single outcome variable, defined as excess body weight. Children with thinness and normal weight were used as the reference group. Waist circumference was analyzed as a continuous anthropometric outcome because locally validated waist circumference cut-off values were not available for this study population.

Foot Posture Assessment

Foot posture was assessed as part of routine clinical screening during school health examinations. Initial inspection was performed by trained family medicine/school health physicians, and children with clinically relevant suspected abnormalities were referred for orthopedic evaluation and further management. For analysis, foot posture was dichotomized as no clinically relevant abnormality versus positive clinical foot posture finding. Because the study was conducted within routine school health assessments, foot posture findings were interpreted as clinical screening findings rather than instrument-based biomechanical measurements.

Study Procedure

Data collection was conducted during routine systematic school health examinations at the Mostar Health Center. Questionnaire data were obtained through physician-led interviews using the structured questionnaire.

Additional clarification was provided when necessary to improve comprehension and response accuracy. When needed, parents or legal guardians assisted in clarifying behavioral responses.

Questionnaire data were coded and de-identified before statistical analysis. Anthropometric measurements and foot posture assessments were obtained during the same examination visit. All data were analyzed in anonymized form.

The study was conducted in accordance with institutional and national ethical standards and with the Declaration of Helsinki and its later amendments. Ethical approval was obtained from the Ethics Committee of the Mostar Health Center (Approval No. 705-37-247/24). Written informed consent was obtained from all parents or legal guardians before participation.

Outcomes

The primary outcome was excess body weight, defined as overweight or obesity according to WHO BMI-for-age criteria. This outcome was selected because the revised analysis focused on anthropometric status and its association with lifestyle habits.

Secondary outcomes were waist circumference and foot posture abnormality. Waist circumference was analyzed as a continuous anthropometric measure. Foot posture abnormality was analyzed as a binary clinical outcome.

The main explanatory variables were recreational screen time, physical activity outside school, outdoor play, dietary habits, sex, grade, and urban/rural residence. Urban/rural residence and sex were analyzed both as descriptive variables and as covariates in multivariable models.

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics, version 20.0 (SPSS Inc., Chicago, IL, USA). The distribution of continuous variables was assessed using the Kolmogorov-Smirnov test and inspection of descriptive distributional parameters. Continuous variables are presented as mean ± standard deviation or median and interquartile range, as appropriate. Categorical variables are presented as frequencies and percentages.

Between-group comparisons were performed according to variable type and analytical purpose. Continuous variables were compared using the independent-samples t test or one-way analysis of variance when comparing more than two groups. Non-parametric alternatives were considered when distributional assumptions were not met. Categorical variables were compared using the chi-square test or Fisher's exact test when expected cell counts were small.

BMI-for-age categories were compared across lifestyle, dietary, and foot posture variables. For multivariable analysis, excess body weight was modeled as a binary outcome. Multivariable logistic regression was used to examine factors associated with excess body weight. The model included recreational screen time ≥3 hours/day, low physical activity outside school, outdoor play <1 hour/day, daily breakfast consumption, daily sweets consumption, frequent fast-food intake, daily fruit consumption, daily vegetable consumption, carbonated drink consumption, sex, grade, and urban/rural residence. Results are presented as odds ratios with 95% confidence intervals.

Waist circumference was analyzed as a continuous outcome using multivariable linear regression. The explanatory variables were the same as those used in the excess body weight model. Results are presented as unstandardized regression coefficients with 95% confidence intervals. This model was used to examine whether lifestyle and dietary variables were associated with waist circumference independently of sex, grade, and place of residence.

Two separate multivariable logistic regression models were fitted to examine factors associated with foot posture abnormality. Model 5A included excess body weight as the main anthropometric predictor, while Model 5B included waist circumference as the main anthropometric predictor. Both models were adjusted for low physical activity, sex, grade, and urban/rural residence. The two anthropometric indicators were not entered simultaneously. Results are presented as odds ratios with 95% confidence intervals.

Complete-case analysis was used for each statistical model, including only participants with complete data for all variables entered into that model. Denominators are therefore reported where relevant. A two-sided *p* value of less than 0.05 was considered statistically significant.

Results

Participant characteristics

A total of 404 fifth- and seventh-grade primary school pupils were included in the study. Of the total sample, 193 were boys (47.5%) and 211 were girls (52.5%). A total of 176 pupils (43.6%) attended the fifth grade, while 228 pupils (56.4%) attended the seventh grade. According to place of residence, 269 pupils (66.6%) lived in an urban area and 135 pupils (33.4%) in a rural area.

The mean body weight was 45.55±11.21 kg, the mean body height was 154.09±10.22 cm, the mean waist circumference was 64.63±8.92 cm, and the mean BMI was 18.96±3.59 kg/m² among participants with valid BMI data. The WHO BMI-for-age z-score could be calculated for 401 children. Three records were excluded from BMI-for-age z-score analysis because of invalid or missing age or anthropometric data; all three excluded records were from girls.

Boys had significantly higher waist circumference and BMI-for-age z-scores than girls, whereas body weight, body height, and BMI values did not differ significantly by sex (Tab. I).

BMI-for-age categories and lifestyle habits

According to WHO BMI-for-age classification, thinness

Tab. I. Baseline characteristics of participants by sex.

Variable	Total	Boys	Girls	*p*
Number of participants, n (%)	404 (100.0)	193 (47.5)	211 (52.5)	–
Age, years	11.30±1.08	11.25±1.09	11.35±1.06	0.383
Body weight, kg	45.55±11.21	45.78±11.58	45.34±10.88	0.699
Body height, cm	154.09±10.22	153.80±11.20	154.36±9.25	0.587
Waist circumference, cm	64.63±8.92	66.14±9.12	63.24±8.53	0.001
BMI, kg/m²	18.96±3.59	19.17±3.48	18.77±3.69	0.256
BMI-for-age z-score	0.29±1.29	0.46±1.40	0.14±1.18	0.014
Excess body weight, n (%)	113/401 (28.2)	67/193 (34.7)	46/208 (22.1)	0.007

Values are presented as mean ± standard deviation or n (%). BMI=body mass index. Excess body weight was defined as overweight or obesity according to WHO BMI-for-age criteria. ***p* values** refer to comparisons between boys and girls.

Tab. II. Lifestyle habits and foot posture findings according to BMI-for-age categories.

Variable	Thinness	Normal weight	Overweight	Obesity	*p*
Number of children, n (%)	14 (3.5)	274 (68.3)	70 (17.5)	43 (10.7)	—
Waist circumference, cm	56.07±3.38	61.22±5.26	70.79±7.46	80.46±9.21	<0.001
BMI-for-age z-score	-2.89±1.14	-0.18±0.74	1.47±0.26	2.41±0.33	<0.001
Screen time ≥3 h/day, n (%)	2/14 (14.3)	70/271 (25.8)	16/66 (24.2)	8/42 (19.0)	0.631
Physical activity <1 h/day, n (%)	0/14 (0.0)	44/270 (16.3)	13/66 (19.7)	12/43 (27.9)	0.083
Outdoor play <1 h/day, n (%)	1/14 (7.1)	22/270 (8.1)	7/66 (10.6)	4/43 (9.3)	0.926
Daily breakfast, n (%)	8/13 (61.5)	151/267 (56.6)	25/65 (38.5)	16/42 (38.1)	0.013
Daily fruit consumption, n (%)	5/14 (35.7)	132/270 (48.9)	26/69 (37.7)	14/43 (32.6)	0.097
Daily vegetable consumption, n (%)	3/14 (21.4)	44/270 (16.3)	9/69 (13.0)	6/43 (14.0)	0.828
Daily sweets consumption, n (%)	5/14 (35.7)	120/270 (44.4)	34/69 (49.3)	19/43 (44.2)	0.791
Fast food ≥several times/week, n (%)	4/14 (28.6)	47/270 (17.4)	18/69 (26.1)	5/43 (11.6)	0.165
Carbonated drinks, n (%)	4/14 (28.6)	71/274 (25.9)	14/70 (20.0)	9/43 (20.9)	0.686
Foot posture abnormality, n (%)	1/14 (7.1)	43/270 (15.9)	11/70 (15.7)	11/42 (26.2)	0.283

Values are presented as mean±standard deviation or n (%). BMI=body mass index. ***p*** values refer to comparisons across BMI-for-age categories.

was identified in 14 children (3.5%), normal weight in 274 children (68.3%), overweight in 70 children (17.5%), and obesity in 43 children (10.7%). Overweight and obesity combined, defined as excess body weight, were present in 113 of 401 children (28.2%).

No statistically significant difference in recreational screen time was observed across BMI-for-age categories. Screen time ≥3 hours/day was reported by 14.3% of children with thinness, 25.8% of children with normal weight, 24.2% of children with overweight, and 19.0% of children with obesity (*p*=0.631).

Low physical activity (<1 h/day) was numerically more frequent among children with overweight and obesity, particularly among children with obesity; however, this difference was not statistically significant (*p*=0.083).

Daily breakfast consumption differed significantly across BMI-for-age categories (*p*=0.013). Children with overweight and obesity were less likely to eat breakfast every day compared with children with normal weight. Other analyzed dietary variables did not differ significantly across BMI-for-age categories (Tab. II).

Association of lifestyle habits with excess body weight

In multivariable logistic regression, screen time ≥3 h/day was not independently associated with excess body weight. Low physical activity and outdoor play <1 h/day were also not significantly associated with excess body weight after adjustment.

Among the analyzed dietary variables, daily breakfast consumption was independently associated with lower odds of excess body weight after adjustment for screen time, physical activity, outdoor play, dietary variables, sex, grade, and place of residence (OR=0.42; 95% CI: 0.26–0.69; *p*=0.001).

Daily fruit consumption was not significantly associated with excess body weight after adjustment (OR=0.61; 95% CI: 0.37-1.00; *p*=0.052). Daily sweets consumption, frequent fast-food intake, daily vegetable consumption, and carbonated drink consumption were also not independently associated with excess body weight. Girls had significantly lower odds of excess body weight compared with boys (Tab. III).

Waist circumference as a continuous anthropometric outcome

Waist circumference was analyzed as a continuous anthropometric measure. In the multivariable linear regression model, screen time ≥3 h/day was not independently associated with waist circumference. Low physical activity and outdoor play <1 h/day were also not significantly associated with waist circumference.

Daily breakfast consumption was not significantly associated with waist circumference after adjustment

Tab. III. Multivariable logistic regression for excess body weight.

Predictor	OR	95% CI	*p*
Screen time ≥3 h/day	0.71	0.39-1.29	0.261
Physical activity <1 h/day	1.57	0.84-2.94	0.157
Outdoor play <1 h/day	1.03	0.43-2.45	0.952
Daily breakfast	0.42	0.26-0.69	0.001
Daily sweets consumption	1.41	0.86-2.30	0.174
Fast food ≥several times/week	0.97	0.50-1.87	0.930
Daily fruit consumption	0.61	0.37-1.00	0.052
Daily vegetable consumption	0.83	0.42-1.64	0.596
Carbonated drinks	0.57	0.31-1.05	0.073
Girls *vs.* boys	0.45	0.27-0.73	0.002
7th *vs.* 5th grade	0.83	0.50-1.36	0.461
Urban *vs.* rural residence	1.11	0.66-1.88	0.699

Outcome: excess body weight, defined as overweight or obesity according to WHO BMI-for-age criteria. OR=odds ratio; CI=confidence interval. All listed predictors were entered simultaneously into the model. Complete-case analysis included 379 participants; number of events=104. Model calibration was acceptable (Hosmer-Lemeshow χ^2=11.16; df=8; ***p***=0.193). Model discrimination was modest (AUC=0.684).

Tab. IV. Linear regression for waist circumference.

Predictor	B	95% CI	*p*
Screen time ≥3 h/day	-0.89	-3.01 to 1.24	0.413
Physical activity <1 h/day	0.56	-1.90 to 3.02	0.657
Outdoor play <1 h/day	-0.33	-3.61 to 2.96	0.846
Daily breakfast	-1.78	-3.60 to 0.03	0.054
Daily sweets consumption	1.35	-0.47 to 3.18	0.145
Fast food ≥several times/week	-2.22	-4.63 to 0.19	0.071
Daily fruit consumption	-1.41	-3.24 to 0.42	0.131
Daily vegetable consumption	-1.82	-4.28 to 0.63	0.145
Carbonated drinks	-1.91	-4.07 to 0.25	0.083
Girls *vs.* boys	-3.97	-5.80 to -2.13	<0.001
7th *vs.* 5th grade	3.53	1.67 to 5.39	<0.001
Urban *vs.* rural residence	-0.21	-2.15 to 1.73	0.832

Outcome: waist circumference in centimeters. B=unstandardized regression coefficient; CI=confidence interval. All listed predictors were entered simultaneously into the model. Complete-case analysis included 367 participants. Model fit: R^2=0.117; adjusted R^2=0.087.

(B=-1.78 cm; 95% CI: -3.60 to 0.03; *p*=0.054). Other dietary variables were not independently associated with waist circumference. Sex and grade were the most stable factors associated with waist circumference: girls had lower waist circumference, whereas seventh-grade pupils had higher waist circumference compared with fifth-grade pupils (Tab. IV).

Foot posture abnormality

Foot posture abnormality was recorded in 67 of 398 children with available data. Foot posture abnormality was slightly more frequent among children with excess body weight than among children without excess body weight, but the difference across BMI-for-age categories was not statistically significant.

Two separate logistic regression models were fitted for foot posture abnormality to avoid simultaneous inclusion of closely related anthropometric indicators. Model 5A included excess body weight as the main anthropometric predictor, while Model 5B included waist circumference as the main anthropometric predictor. Both models were adjusted for low physical activity, sex, grade, and urban/rural residence.

In Model 5A, excess body weight was not independently associated with foot posture abnormality. Low physical activity and urban residence were independently associated with higher odds of foot posture abnormality. In Model 5B, waist circumference was not independently associated with foot posture abnormality. Low physical activity and urban residence remained independently associated with higher odds of foot posture abnormality (Tab. V).

Urban/rural and sex differences

In the additional urban/rural analysis, no significant differences were found between rural and urban children in BMI-for-age categories, excess body weight, BMI, BMI-for-age z-score, or waist circumference. However,

Tab. V. Logistic regression models for foot posture abnormality.

Predictor	Model 5A OR	95% CI	*p*	Model 5B OR	95% CI	*p*
Excess body weight	1.33	0.73-2.40	0.347	-	-	-
Waist circumference	-	-	-	1.02	0.98-1.05	0.316
Physical activity <1 h/day	2.20	1.16-4.18	0.016	2.34	1.23-4.45	0.009
Girls *vs.* boys	0.90	0.52-1.57	0.719	0.96	0.55-1.67	0.875
7th *vs.* 5th grade	1.60	0.91-2.80	0.103	1.53	0.86-2.74	0.149
Urban *vs.* rural residence	2.26	1.17-4.36	0.015	2.25	1.16-4.39	0.017

Outcome: foot posture abnormality.
OR: odds ratio; CI: confidence interval. Model 5A included excess body weight, physical activity <1 h/day, sex, grade, and urban/rural residence. Model 5B included waist circumference, physical activity <1 h/day, sex, grade, and urban/rural residence. The two anthropometric indicators were not entered simultaneously. Model 5A included 388 participants with complete data; number of events =65; Hosmer-Lemeshow χ^2=5.08; df=8; *p*=0.749; AUC=0.639. Model 5B included 376 participants with complete data; number of events =64; Hosmer-Lemeshow χ^2=5.29; df=8; ***p***=0.726; AUC=0.641.

urban children more frequently had screen time ≥3 h/day compared with rural children (28.8% *vs.* 16.8%; *p*=0.009) and more frequently spent less than 1 h/day in outdoor play (11.0% *vs.* 4.6%; *p*=0.035). Foot posture abnormality was also more frequent among urban than rural children (19.9% *vs.* 10.7%; *p*=0.022).

By sex, boys more frequently had excess body weight than girls (34.7% *vs.* 22.1%; *p*=0.007). The distribution of BMI-for-age categories also differed significantly by sex, with overweight and obesity being more frequent among boys. Screen time ≥3 h/day, low physical activity, and foot posture abnormality did not differ significantly between boys and girls.

Discussion

In this regional cross-sectional study of fifth- and seventh-grade schoolchildren, excess body weight was present in more than one quarter of participants. The main findings were that recreational screen time was not independently associated with excess body weight or waist circumference, whereas daily breakfast consumption was associated with lower odds of excess body weight. Daily fruit consumption showed a similar direction of association but did not reach statistical significance after adjustment. Girls had lower odds of excess body weight than boys. Waist circumference was mainly associated with sex and grade, while foot posture abnormalities were not independently associated with excess body weight or waist circumference. However, low physical activity and urban residence were associated with higher odds of foot posture abnormality. These findings suggest that anthropometric status, lifestyle habits, and clinical foot findings should be interpreted as related but distinct components of school health surveillance.

The observed prevalence of excess body weight confirms that childhood overweight and obesity represent an important regional public health issue [12]. In the present study, 28.2% of children had overweight or obesity according to WHO BMI-for-age criteria. This proportion is clinically relevant because childhood overweight and obesity are associated with later cardiometabolic risk, including insulin resistance, dyslipidemia, elevated blood pressure, and persistence of obesity into adolescence and adulthood [13]. Recent COSI-based work also confirms that standardized school-based monitoring is essential for identifying childhood obesity and related behavioral patterns across countries [6]. Therefore, the present results support the value of routine school health examinations as a practical regional surveillance platform in Bosnia and Herzegovina.

The sex difference in excess body weight deserves particular attention. Boys had higher BMI-for-age z-scores and a higher prevalence of excess body weight than girls, even though BMI values alone did not differ significantly by sex. This supports the importance of using age- and sex-specific BMI-for-age classification rather than interpreting crude BMI values alone in children. Sex differences in childhood obesity are commonly reported across populations, although their direction and magnitude may vary by age, pubertal timing, physical activity, diet, and sociocultural context [14]. In this study, the lower odds of excess body weight among girls remained significant after adjustment for lifestyle variables, grade, and place of residence. This finding indicates that sex should be retained as an important covariate in regional child health analyses.

Recreational screen time was not independently associated with excess body weight in this sample. This finding differs from parts of the broader literature, where higher screen exposure has often been linked to adiposity and less favorable health behaviors in children. However, the absence of an independent association in the present study may reflect several factors. Screen time was self-reported and measured in broad categories, total sedentary time was not objectively measured, and screen exposure may influence body weight through pathways not fully captured here, such as snacking, sleep, parental rules, or total energy intake [15-17]. COSI data show substantial levels of excessive screen time among European children, and screen-based leisure remains a relevant surveillance target [1]. Thus, the present finding should not be interpreted as evidence that screen exposure is irrelevant, but rather that it was not an independent anthropometric correlate in this specific regional dataset after adjustment.

Physical activity showed different patterns depending on the outcome examined. Low physical activity was not independently associated with excess body weight or waist circumference, but it was associated with higher odds of foot posture abnormality. This supports the view that movement-related behaviors should not be reduced to a single obesity-related indicator. Physical activity may influence musculoskeletal function, postural control, lower-limb strength, and foot loading patterns even when its association with BMI is weak or not statistically significant. Recent surveillance literature emphasizes that physical activity and sedentary behavior should be monitored as distinct but related domains, because each may have different determinants and health consequences [7]. In the present study, low physical activity appeared more relevant to foot posture findings than to anthropometric outcomes.

Daily breakfast consumption was the most consistent dietary correlate of excess body weight in the adjusted model. Children who reported eating breakfast every day had substantially lower odds of excess body weight after adjustment for screen time, physical activity, outdoor play, other dietary variables, sex, grade, and place of residence. This finding is consistent with a recent systematic review and meta-analysis suggesting that breakfast skipping is associated with higher odds of overweight or obesity in children and adolescents [18]. The observed association may reflect broader household routines, better overall diet quality, more regular meal timing, or lower likelihood of compensatory snacking later in the day. Because the study was cross-sectional, this association should not be interpreted causally. Nevertheless, breakfast habits may represent a simple and practical marker for school health counseling.

Daily fruit consumption showed a similar direction of association with excess body weight, but it did not reach statistical significance after adjustment. This result should be interpreted cautiously because fruit intake was self-reported, analyzed as a simplified binary variable, and had a confidence interval close to 1.00. It may reflect a broader pattern of healthier dietary routines rather than an isolated protective effect of fruit intake [19]. In contrast, daily sweets consumption, frequent fast-food intake, daily vegetable consumption, and carbonated drink consumption were not independently associated with excess body weight. These findings may partly reflect measurement limitations, small subgroup sizes, social desirability bias, or residual confounding. The inverse direction observed for frequent fast-food intake in the waist circumference model was not statistically significant and should not be interpreted as protective. It may reflect reporting bias, reverse behavior change among children with higher weight, or residual confounding.

Waist circumference provided information that complemented BMI-for-age classification [20]. Waist circumference increased across BMI-for-age categories and was strongly associated with sex and grade in multivariable analysis. However, screen time, physical activity, outdoor play, and dietary variables were not independently associated with waist circumference after adjustment. The linear regression model explained a limited proportion of the variance in waist circumference, suggesting that important determinants were not captured. These may include pubertal development, parental adiposity, genetic factors, detailed dietary intake, sleep duration, and objectively measured physical activity. Because waist circumference reflects central adiposity more directly than BMI, future studies in this population should consider locally relevant waist circumference references or waist-to-height ratio to improve cardiometabolic risk stratification [20, 21].

Foot posture abnormalities showed a different pattern from anthropometric outcomes. Excess body weight and waist circumference were not independently associated with foot posture abnormality in the present analysis, whereas low physical activity and urban residence were consistently associated with higher odds of abnormal foot posture. This finding partly differs from recent literature suggesting that pediatric flatfoot is often associated with elevated BMI and obesity [22, 23]. Several explanations are possible. First, foot posture in this study was assessed as a clinical screening finding rather than by podoscope, plantar pressure analysis, or a validated foot posture index. Second, the outcome included broader clinical foot posture abnormalities and may not correspond exactly to instrument-defined flatfoot. Third, the number of positive foot findings was modest, limiting statistical power. These differences in case definition and measurement method may explain why BMI and waist circumference were not significant predictors in this sample.

The association between urban residence and foot posture abnormality is clinically interesting but should be interpreted cautiously. Urban residence remained associated with higher odds of foot posture abnormality even after adjustment for physical activity, sex, grade, and anthropometric indicators. Recent pediatric flatfoot research has also reported higher prevalence among urban children and associations with insufficient physical activity, although mechanisms remain uncertain [24]. Possible explanations include differences in habitual movement, footwear patterns, surfaces used for play, access to outdoor activity, or referral and detection patterns during clinical screening [24]. Because these contextual variables were not directly measured, urban residence should be interpreted as a contextual marker rather than a causal factor.

The public health implications of these findings are practical for school health services. Routine school health examinations can identify not only excess body weight, but also behavioral and clinical patterns that may require counseling or follow-up. The results suggest that school health strategies should address regular meal routines, physical activity, and opportunities for active play, while also recognizing that anthropometric and musculoskeletal findings may have different correlates [25, 26]. This is consistent with the broader role of school-based surveillance systems, which provide standardized, repeated, and locally actionable information for child health planning [6, 7]. In Bosnia and Herzegovina, where standardized regional data remain limited, routine school health services may be an important foundation for future surveillance.

Several limitations should be considered when interpreting these findings. First, the cross-sectional design precludes conclusions about temporal direction or causality. Second, lifestyle and dietary variables were self-reported during physician-led interviews and may be affected by recall bias and social desirability bias. Third, the questionnaire was adapted from established surveillance items but was not formally validated as a standalone instrument in the primary school population of Bosnia and Herzegovina. Fourth, physical activity and screen time were assessed using categorical self-report rather than accelerometry or digital tracking. These limitations may have reduced precision and weakened the ability to detect associations between lifestyle behaviors and anthropometric outcomes.

Additional methodological limitations relate to anthropometric classification, missing data, and model performance. BMI-for-age classification requires accurate age and sex information; three records could not be classified because of invalid or missing age or anthropometric data, and minor misclassification around category thresholds cannot be fully excluded. Missing data were handled using complete-case analysis, which may introduce selection bias if excluded records differed systematically from included records. The logistic regression models showed acceptable calibration but modest discrimination, and the waist circumference model explained a limited proportion of variance. These findings indicate that unmeasured factors, including socioeconomic status, parental BMI, pubertal stage, sleep duration, total energy intake, and objectively measured activity, may be important determinants of child anthropometric status and foot posture.

The foot posture assessment also has specific limitations. Foot posture abnormality was based on clinical screening during routine school health examination rather than instrument-based biomechanical measurement. Therefore, the outcome should be interpreted as a clinical screening finding, not as a definitive diagnosis of flatfoot or another specific structural foot disorder. Differences in examiner judgment and the absence of standardized foot posture indices may have introduced classification variability. Future studies should consider using podoscopic assessment, plantar pressure analysis, or validated foot posture indices to better characterize pediatric foot posture in relation to BMI, waist circumference, and physical activity [10, 11, 24].

Despite these limitations, the study has several strengths. It included a regional school-based sample embedded in routine preventive health care, reducing the likelihood that the sample reflected only children seeking care for illness. The study also combined BMI-for-age categories, waist circumference, dietary habits, screen time, physical activity, outdoor play, and foot posture findings in the same analytical framework. This integrated approach is relevant for primary care and school health practice because it reflects the type of multidimensional assessment that can realistically be performed during routine preventive examinations. The findings therefore provide useful regional evidence for school health planning in the Mostar area and may inform future standardized surveillance efforts in Bosnia and Herzegovina.

Conclusion

In this regional sample of fifth- and seventh-grade schoolchildren, excess body weight was present in more than one quarter of participants. Recreational screen time was not independently associated with excess body weight or waist circumference, whereas daily breakfast consumption was associated with lower odds of excess body weight. Daily fruit consumption showed a similar direction of association but did not reach statistical significance after adjustment. Foot posture abnormalities were not independently associated with excess body weight or waist circumference, but were associated with low physical activity and urban residence. These findings support school health strategies that combine anthropometric monitoring, counseling on regular dietary routines, promotion of physical activity, and clinical screening for musculoskeletal findings during routine preventive examinations.

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Conflict of interest statement

The authors declare no conflict of interest.

Authors' contributions

IM contributed to the conception and design of the study, coordination of the research process, organization of data collection, data acquisition, database preparation, statistical analysis, interpretation of results, drafting of the manuscript, and preparation of the final version. MP contributed to data acquisition during routine school health examinations, clinical data verification, interpretation of results, and critical revision of the manuscript. DV contributed to interpretation of clinical and school health findings, verification of clinical terminology, and critical revision of the manuscript for important intellectual content. BO contributed to interpretation of musculoskeletal findings, interpretation of foot posture abnormalities, and critical revision of the manuscript for important intellectual content. MK contributed to interpretation of musculoskeletal and clinical foot posture findings, verification of clinical terminology related to foot posture assessment, and critical revision of the manuscript for important intellectual content. BP contributed to study design, methodological supervision, interpretation of results, supervision of manuscript structure, and critical revision of the manuscript for important intellectual content. All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Correspondence: Igor Maslać, Department of Family Medicine, Health Center Mostar Hrvatskih branitelja b.b., Mostar, Bosnia and Herzegovina. E-mail: igor.maslac@fzs3.sum.ba

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