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RESEARCH

Prevalence of childhood overweight – obesity and associated factors: A school-based, cross-sectional study northern Algeria

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Abstract

Purpose To determine the prevalence of overweight/obesity and stunting among primary schoolchildren, and the associated factors.

Methods This is a cross-sectional study conducted from February to September 2023 across 577 primary schools in Bejaia Province, Northern Algeria. Schoolchildren's anthropometric measurements (weight and height) were obtained through direct physical assessments and were subsequently used to classify their weight and growth status according to WHO growth reference standards. Dietary habits school environment, and physical activity levels were obtained using survey questionnaires. Multivariate logistic regression analyses were performed to assess the associations between overweight/obesity and factors including dietary habits, physical activity, and the school environment.

Results Overall, 446 (77.3%) primary schools participated in the study yielding a sample of 14,283 schoolchildren aged 9–13 years. Boys had a higher prevalence of obesity and severe obesity compared to girls. Overweight prevalence peaked at age 10 in girls (23.11%, 95% CI: 21.42–24.85%) while obesity peaked in boys at age 9 (18.80%, 95% CI: 11.14–28.76%). Obesity was strongly associated with stunting, particularly in boys (aOR = 5.78, 95% CI: 4.41–7.66, $p < 0.001$). Engagement in sportive activities was associated with lower overweight/obesity prevalence, while frequent snacking showed positive associations. Overweight and obesity were more prevalent in urban and suburban schools compared to rural settings.

Conclusion This study reveals concerning patterns of childhood overweight/obesity and stunting in northern Algeria, highlighting the urgent need for targeted public health interventions addressing nutritional education and physical activity promotion.

Keywords Bejaïa province · School environment · Dietary habits · Physical activity · Stunting

Introduction

Obesity and overweight pose major global health challenges, contributing to the rise of non-communicable diseases (NCDs) affecting individuals of every age, sex, and ethnicity [1–3]. Childhood obesity remains an important challenge in global health, with growing concern about increasing rates as the number of children aged 5 to 19 years with obesity is predicted to rise to 254 million by 2030 [4]. The prevalence of obesity is predominantly influenced by modifiable factors, such as unhealthy eating habits and inadequate physical activity, which are often shaped by the school environment. These lifestyle-related variables contribute to over 90% of obesity cases, while hormonal or genetic alterations account for a mere 10% [5–7]. Understanding these modifiable

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factors, particularly in school-aged children, is crucial for developing effective intervention strategies that can prevent the long-term health consequences of childhood obesity and potentially reverse current trends.

In children, the relationship between Body Mass Index (BMI) and their level of adiposity is subject to variations based on their age, and sex. Consequently, BMI cut-off points are usually derived from specific percentiles on a growth reference curve [8]. Children's physical and mental health risks are strongly associated with extremely BMI values [9–11]. Childhood is a vital period for developing long-term health habits, and having obesity during these years raises the risk of remaining affected by the latter into adulthood [12]. Unlike children with overweight or obesity, who may not show apparent morbidities during their childhood, children with severe obesity often suffer from immediate health consequences. These include a poorer cardiometabolic risk profile, early signs of vascular dysfunction, and subclinical atherosclerosis [13, 14]. Moreover, children with severe obesity are more susceptible to depression, which is often caused by teasing and bullying, and they also face additional social risks [15, 16].

In addition to the rising rates of obesity and overweight, stunting remains a major issue in many parts of the world, often coexisting with the obesity epidemic, especially in low- and middle-income countries [17]. Stunting, defined as impaired growth and development due to chronic malnutrition during critical periods of early life, can have lasting effects on both physical and cognitive development [18]. Interestingly, recent studies suggest a relationship between stunting and obesity, where children who experience maternal undernutrition, stunted growth early in life are more likely to develop obesity later on [19, 20], supporting the theory of the early origins of chronic diseases [21]. This phenomenon, known as the 'double burden of malnutrition,' reflects the complex interplay between undernutrition and overnutrition in the same populations. Children who are stunted may have altered metabolism, making them more susceptible to excess weight gain when exposed to high-calorie, low-nutrient diets [22].

In Algeria, among children and adolescents aged 5 to 19 years, the prevalence of obesity has risen sharply, from 4.6% [1.68%–9.11%] in 1990 to 15.3% [8.31%–23.9%] in 2022, marking an increase of 10.7%. This growth rate surpasses the average rise in Africa (3.93%) and globally (8.23%) [23]. Despite these concerning trends, comprehensive data on childhood overweight and obesity and stunting in Algeria remain limited in the current literature, particularly regarding the roles of dietary habits and physical activity in different primary school environments.

This study aimed to fill this gap by: (*i*) estimating the prevalence of overweight, obesity, and stunting among primary school children in Bejaïa province; (*ii*) elucidating sex-specific differences in dietary habits and physical activity levels among schoolchildren; and (*iii*) assessing the interrelationships between the school environment, children's physical activity, dietary habits, and the co-occurrence of stunting and obesity. Insights gained from this study can inform strategies to tackle childhood obesity and stunting locally and in similar contexts globally, contributing to the broader public health effort.

Methods

Ethical approval

The study protocol was approved by the Ethical Committee of Bejaia University (Algeria), the local Data Protection Board (DPB), and the director of the Wilaya's Education Department. Participation was voluntary, and prior to data collection, written informed consent was obtained from parents or legal guardians, in accordance with Law No. 18–07 of June 10, 2018, for their children's participation and use of data in publications. A Data Management Plan (DMP) outlined data collection, management, and preservation. Personal identifiers were removed immediately after collection and not stored outside the research center. Data sharing occurred via personal computers and institutional servers, with anonymous datasets available upon request after the study completion.

Study area and participants

We conducted a cross-sectional school-based study in Bejaïa province, located in northern Algeria, which has approximately 912,577 inhabitants. The study was carried out from February 2023 to September 2023. The target population consisted of all fifth-grade schoolchildren in the primary schools of the province ($n = 18{,}964$). This group was chosen because they were typically aged 9 years and older, making them more capable of answering the questionnaires, and their parents were more likely to participate actively in the study.

Initially, all primary schools of the province ($n = 577$) were invited to participate in the study. Overall, 56% ($n = 323$) of the primary schools were rural, while 20% ($n = 121$) were sub-urban and 24% ($n = 133$) were categorized urban. This categorization was based on the environmental characteristics of their locations, following a classification system disclosed by the directors of each school to the Ministry of Education. The school environment is often reflective of the schoolchildren' residential environment and is recognized to have an impact on their lifestyle habits [7]. Due to the need for specific permission from the Primary Education Department of Bejaia, schools from other Wilayas were not included. Furthermore, education in Algeria is both free and mandatory, ensuring that children from all social backgrounds are represented [7].

Two workshops were organized; inviting directors from all 577 participating primary schools (refer to supplementary data videos). These workshops were designed to provide comprehensive guidance on completing the questionnaire used for our study. The initial workshop was held in February, followed by a subsequent session in March, ensuring ample opportunity for the directors to understand and clarify the process. Schoolchildren who did not give consent, those who were not present on the survey day, and those with eating disorders, physical disabilities, or specific medication treatments were excluded from the study.

Data collection procedures

Anthropometric measurements

Weight and height measurements were conducted in the presence of the school assistant, following the guidelines set by the WHO guidelines [24]. Height was recorded using a stadiometer with an accuracy of 1 mm. Before the measurements, schoolchildren were instructed to remove their shoes and stand in an upright anatomical position [25]. Body weight was assessed using a calibrated scale (Terraillon, Croissy-sur-Seine, France) that provides measurements with a precision of 0.1 kg. To ensure accuracy, children's weights were recorded without shoes and while wearing lightweight clothing, rounded to the nearest 50 g.

Child height and weight were used to calculate age- and sex-specific Body Mass index z-scores (zBMI) and height-for-age z-scores (HAZ) following the WHO Growth Reference [26]. Children were categorized based on their zBMI scores according to the WHO growth reference BMI-for-age and sex cutoffs for 5–19 years [24] as follow; Severe Thinness (zBMI < -3), Thinness (-3 ≤ zBMI < -2), Normal Weight (-2 ≤ zBMI ≤ + 1), Overweight (+ 1 < zBMI ≤ + 2), Obese (+ 2 < zBMI ≤ + 3), and Severe Obesity (zBMI > + 3). Children with HAZ below -2 standard deviations from the median of the WHO Child Growth Standards were classified as stunted. The prevalence of each weight status category and stunting was calculated separately for each school environment, age group (only for weight status categories), and sex. Prevalence, defined as the proportion of individuals within a specific anthropometric category relative to the total number of individuals, was determined with 95% confidence intervals (CIs).

Dietary habits

Dietary habits were assessed using a modified food-frequency questionnaire (FFQ) developed for this study. The questionnaire was based on existing FFQs but adapted to the local context [27]. To enhance its reliability and applicability, we conducted a pilot study with over 800 respondents to refine the questionnaire. The school directors assigned assistants to help in completing the questionnaires. Although children self-reported their dietary habits, assistants provided guidance to ensure clarity and completeness of responses. We selected several dietary habit variables that are potential indicators of diet quality in children, including number of meals, starch and grains portions, eating between meals, between-meal food type, bakery products, milk consumption, processed food, sugary beverages, and fast-food consumption. The responses were transformed into times/week or times/day of intake [28]. The responses were transformed into times/week or times/day of intake. Fast food frequency were categorized as (< 1 time/week, ≥ 1 times/week), as studies suggests that the consumption of fast food more than once a week is associated with increased health risks for children [29]. In addition to the main meals, data on children's snack consumption between meals was also collected. Snacks were categorized into four groups according to the NOVA classification, which is based on the degree of food processing. The first group, NOVA 1: Unprocessed or Minimally Processed Foods, included items like plain milk and fresh fruits. The second group, NOVA 2: Processed Culinary Ingredients, included foods such as honey, butter, and margarine. The third group, NOVA 3: Processed Foods, included products like cheese and yogurt. The final group, NOVA 4: Ultra-Processed Foods, comprised snacks like biscuits, chocolate, sugary drinks, and sweets [30].

Physical activity

Physical activity levels were evaluated using a questionnaire specifically designed for this study, inspired from the Physical Activity Questionnaire for Older Children (PAQ-C) [31]. The questionnaire included inquiries about engaging in sportive physical activities (SPA) lasting at least 30 min per week, as well as questions regarding children's active commuting to school (e.g., walking or cycling). Participants reported the frequency and regularity of these activities. This approach aimed to capture a wide range of physical activity, including both organized sports and daily active commuting, while ensuring that the assessment remained straightforward and easy for participants.

Statistical analysis

After data cleaning, which involved the exclusion of invalid entries and the identification and removal of outliers to ensure reliability (Fig. 1), BMI and HFA z-scores were calculated for each age-sex group following the WHO growth reference using the 'zscorer' package [32]. Descriptive

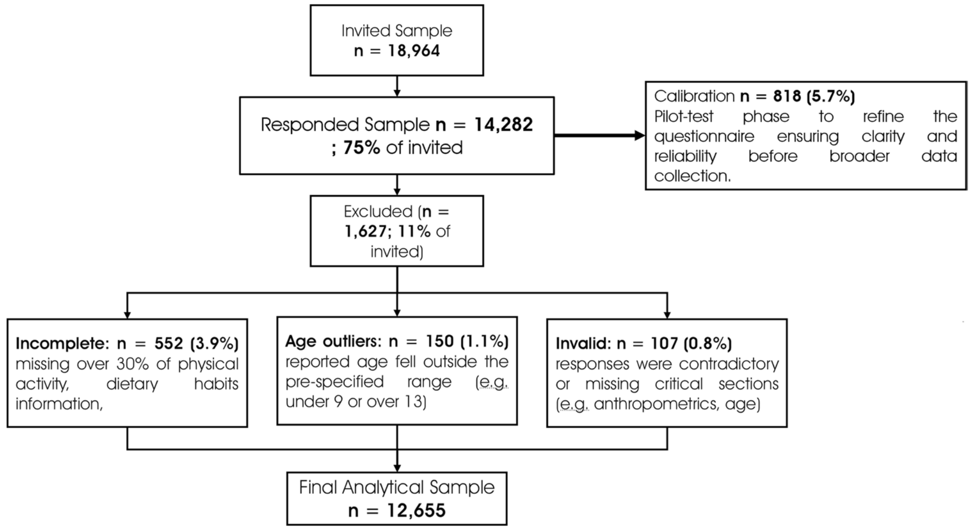

Fig. 1 Data curation procedure for cleaning invalid and missing entries used in this study

statistics were calculated using the "gtsummary" package [33], reporting means and standard deviations (SD) for continuous variables, and absolute counts (with percentages) for categorical variables. Sex differences were assessed using Pearson's Chi-squared test for categorical data and the Wilcoxon rank-sum test for non-normally distributed continuous data. Additionally, the Standardized Mean Difference (SMD) was used to quantify effect size; SMD values are interpreted using Cohen's guidelines: 0.2 as small, 0.5 as medium, and 0.8 as large effects.

To examine the association between the studied factors and overweight/obesity in schoolchildren, two separate multivariate logistic regression models were fitted, stratified by sex, with the binary outcome of overweight/obesity (including severe obesity) versus normal weight. To account for class imbalance in the outcome variable, the Random Over-Sampling Examples (ROSE) package [34] was employed to balance the distribution between the overweight/obesity and normal weight groups. Prior to model fitting, multicollinearity among predictor variables was evaluated using the generalized variance inflation factor (GVIF), with all values remaining below the established threshold of 3. Variable selection was performed by applying the Least Absolute Shrinkage and Selection Operator (LASSO) method using the "cv.glmnet" function from the "glmnet" package [35]. This approach enhances model parsimony and mitigates overfitting by imposing a penalty that shrinks some coefficients to zero, effectively performing variable selection. We selected the optimal penalty parameter (λ) using tenfold cross-validation. The final model retained only those variables with non-zero coefficients at $\lambda = \lambda\_min$, the value that minimized cross-validation error. To provide a clearer understanding of confounder adjustment, both unadjusted (crude) odds ratios (ORs) and adjusted odds ratios (aORs) with 95% confidence intervals (CIs) were provided for both models. Statistical significance was set at $\alpha = 0.05$ for all analyses. Continuous variables are reported as mean ± SD. All statistical analyses were performed using R statistical software (version 4.2.2) [36].

Results

Characteristics of the study sample

The study involved fifth-grade primary schoolchildren of Bejaia province, northern Algeria. Out of the total 577 primary schools contacted, 446 (77%) agreed to join the study. Of the total number of children contacted at these schools ($n = 18{,}964$), 14,283 (75%) agreed to participate. After removing invalid entries and outliers (Fig. 1), the final analytical sample consisted of 12,655 participants. A total of 72 (18%) of the participating schools were identified as urban, 92 (21%) were semi-urban, and 251 (55%) were rural. Schoolchildren's mean age was 10.72 ± 0.71 years (range: 9—13). In total, 12,655 pupils participated, with an almost equal split (Fig. 2A) between boys (50.49%, $n = 5{,}675$) and girls (49.50%, $n = 5{,}564$). The population comprised predominantly children aged 10 (35%, $n = 3{,}948$) and 11 years (53%, $n = 6{,}001$). Urban schoolchildren showed the highest participation rate of 46% ($n = 5{,}144$), followed by rural 31% ($n = 3{,}482$), and suburban with 23% ($n = 2{,}613$).

Table 1 presents baseline characteristics of the study population ($N = 12{,}655$), stratified by sex (boys: $n = 6{,}438$; girls: $n = 6{,}217$). Anthropometric analyses revealed statistically significant sex differences. Boys had slightly higher mean weight (38.48 vs. 37.66 kg; difference: 0.09, 95% CI: 0.06–0.13, $p < 0.001$) and height (143.49 vs. 142.81 cm; difference: 0.07, 95% CI: 0.03–0.10, $p < 0.001$) compared to girls. BMI measurements showed similar patterns, with

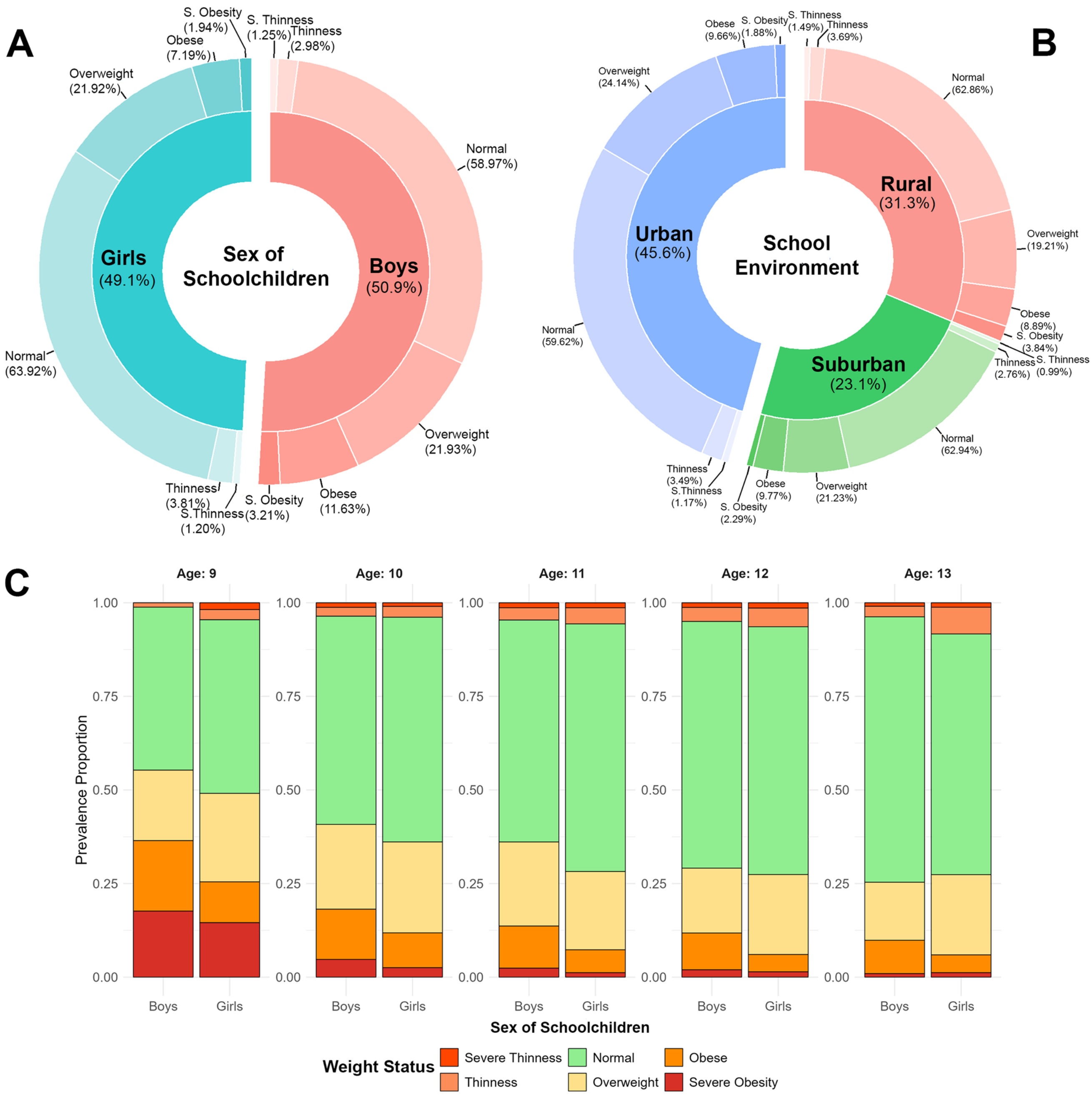

Fig. 2 Weight status categories prevalence proportions among schoolchildren in Bejaia Province stratified by (**A**) sex, (**B**) school environment, and (**C**) age

boys having marginally higher values (18.68 vs. 18.47 kg/m^2; difference: 0.06, 95% CI: 0.02–0.09, $p=0.004$). More pronounced differences were observed in standardized scores, with boys demonstrating higher BMI z-scores (0.49 vs. 0.29; difference: 0.14, 95% CI: 0.11–0.18, $p<0.001$) and height-for-age z-scores (0.21 vs. 0.01; difference: 0.13, 95% CI: 0.09–0.16, $p<0.001$).

Weight classification analysis revealed identical overweight prevalence between sexes (22%, $p=1.000$), while significant differences emerged in obesity and severe obesity. Boys exhibited higher rates of obesity (12% vs. 7.2%, $p<0.001$) and severe obesity (3.2% vs. 1.9%, $p<0.001$). Conversely, girls showed a slightly higher prevalence of stunting (7.8% vs. 5.6%, $p<0.001$), though both sexes

Table 1 Sex-specific baseline characteristics of the study sample ($N = 12,655$)

Characteristics	Overall, $N = 12,655$	Boys, $N = 6,438$	Girls, $N = 6,217$	Difference, (95% CI)	P-value
Age (SD)	10.73 (0.71)	10.80 (0.75)	10.65 (0.66)	0.20 (0.17, 0.24)	< 0.001
Environment (%)				0.03 (0.01, 0.06)	0.311
Rural	3,956 (31%)	2,043 (32%)	1,913 (31%)		
Suburban	2,925 (23%)	1,500 (23%)	1,425 (23%)		
Urban	5,774 (46%)	2,895 (45%)	2,879 (46%)		
Weight kg (SD)	38.08 (8.83)	38.48 (8.98)	37.66 (8.65)	0.09 (0.06, 0.13)	< 0.001
Height cm (SD)	143.16 (10.13)	143.49 (10.11)	142.81 (10.14)	0.07 (0.03, 0.10)	< 0.001
Body Mass Index kg/m^2 (SD)	18.6 (3.89)	18.68 (3.92)	18.47 (3.85)	0.06 (0.02, 0.09)	0.004
BMI Z-score	0.39 (1.42)	0.49 (1.47)	0.29 (1.37)	0.14 (0.11, 0.18)	< 0.001
HFA Z-score	0.11 (1.55)	0.21 (1.52)	0.01 (1.57)	0.13 (0.09, 0.16)	< 0.001
Weight status categories (%)				0.18 (0.15, 0.22)	< 0.001
Severe Thinness	156 (1.2%)	81 (1.3%)	75 (1.2%)		1.000
Thinness	429 (3.4%)	192 (3.0%)	237 (3.8%)		0.063
Normal	7,771 (61%)	3,797 (59%)	3,974 (64%)		< 0.001
Overweight	2,775 (22%)	1,412 (22%)	1,363 (22%)		1.000
Obese	1,196 (9.5%)	749 (12%)	447 (7.2%)		< 0.001
Severe Obesity	328 (2.6%)	207 (3.2%)	121 (1.9%)		< 0.001
Growth Status (%)				0.09 (0.06, 0.13)	< 0.001
Normal	11,811 (93%)	6,080 (94%)	5,731 (92%)		< 0.001
Stunted	844 (6.7%)	358 (5.6%)	486 (7.8%)		< 0.001

Values are presented as mean (SD) for continuous variables and absolute counts n (%) for categorical variables. Difference represents standardized mean difference (SMD) between boys and girls with 95% confidence interval (CI). *P*-values were calculated using Wilcoxon rank sum test for continuous variables and Pearson's Chi-squared test for categorical variables, with pairwise comparisons performed for weight status categories and growth status between sexes. *BMI* body mass index, *HFA* height-for-age

demonstrated predominantly normal growth status (boys: 94%, girls: 92%).

Schoolchildren distribution was similar for both sexes across school settings, with approximately 31–32% from rural areas, 23% from suburban regions, and 45–46% from urban settings ($p = 0.311$ for overall school environment differences).

The anthropometric measurements for boys and girls across age groups (9–13 years) are presented in supplementary material (Table S1). Age-specific comparisons revealed significant differences primarily at ages 10–12. At age 10, significant differences were found in BMI z-score (boys: 0.63 ± 1.51, girls: 0.48 ± 1.35; $p < 0.001$) and HFA z-score (boys: 0.69 ± 1.50, girls: 0.48 ± 1.54; $p < 0.001$). At age 11, weight differed significantly (boys: 38.39 ± 8.63 kg, girls: 37.76 ± 8.59 kg; $p = 0.003$), as did BMI z-score (boys: 0.45 ± 1.44, girls: 0.17 ± 1.34; $p < 0.001$) and HFA z-score (boys: 0.04 ± 1.42, girls: -0.25 ± 1.46; $p < 0.001$). At age 12, BMI z-score (boys: 0.30 ± 1.36, girls: 0.09 ± 1.35; $p = 0.028$) and HFA z-score (boys: -0.31 ± 1.59, girls: -0.73 ± 1.72; $p < 0.001$) continued to show significant differences. No significant differences were observed in most anthropometric indicators at ages 9 and 13 ($p = 0.38$—0.95).

Children's weight and growth status

Weight status categories prevalence

The prevalence of weight status categories among primary schoolchildren in Bejaia, stratified by age, sex, and environment, is presented in Supplementary Tables S2 and S3. Overall, the maximum prevalence of severe thinness and thinness was 7.14%, with higher rates generally observed in older age groups. Normal weight prevalence demonstrated an age-related increasing trend for both sexes (Fig. 2C). Among boys, normal weight prevalence increased from 43.53% (95% CI: 32.80–54.72) at age 9 to 70.89% (95% CI: 64.29–76.90) at age 13. For girls, the prevalence ranged from 46.36% (95% CI: 36.80–56.12) at age 9, peaking at 66.13% (95% CI: 64.50–67.73) at age 11. Overweight prevalence was consistently higher among girls across all age groups. The highest overweight prevalence was observed at age 10 for both sexes: 23.11% (95% CI: 21.42–24.85) for girls and 23.07% (95% CI: 21.29–24.93) for boys. In contrast, obesity and severe obesity showed higher prevalence rates among boys. Obesity prevalence peaked at age 9 for boys (18.82%, 95% CI: 11.16–28.76), while for girls the peak occurred at age 10 (9.26%, 95% CI: 8.12–10.50). Similarly, severe obesity was highest at age 9 for both boys (17.65%, 95% CI: 10.23–27.43) and girls (14.55%, 95% CI: 8.55–22.54), with a notable decreasing trend observed with increasing age.

The prevalence of weight status categories varied across different school environments and between sexes (Fig. 2B). Overweight prevalence was highest in urban schools for both boys (24.11%, 95% CI: 22.56–25.71) and girls (24.18%, 95% CI: 22.62–25.78). Rural areas showed the lowest overweight prevalence for both boys (19.24%, 95% CI: 17.55–21.01) and girls (19.18%, 95% CI: 17.44–21.02). For obesity, boys displayed the highest prevalence in suburban schools (12.13%, 95% CI: 10.52–13.89), while rural schools showed the lowest rates (11.26%, 95% CI: 9.92–12.71). Among girls, obesity was most prevalent in urban schools (7.68%, 95% CI: 6.73–8.71) and lowest in rural areas (6.38%, 95% CI: 5.32–7.57). Interestingly, severe obesity demonstrated a distribution contrary to overweight and obesity, with the highest prevalence in rural areas for both boys (4.41%, 95% CI: 3.56–5.39) and girls (3.24%, 95% CI: 2.49–4.14), and the lowest in urban areas for both sexes (2.49%, 95% CI: 1.95–3.12 for boys; 1.29%, 95% CI: 0.91–1.77 for girls).

Growth status prevalence patterns

The prevalence of stunting varied significantly across weight status categories and environments (Fig. 3). A strong association was found between weight status and stunting prevalence ($p < 0.001$, Cramer's $V > 0.2$), with the highest prevalence in children having obesity (21.07%, 95% CI: 19.04–23.10%) and lowest in schoolchildren with a normal weight (4.04%, 95% CI: 3.60–4.47%). Moreover, the school environment showed a moderate but significant association with stunting prevalence ($p < 0.001$, Cramer's $V = 0.10$), with rural areas having the highest rates (10.24%, 95% CI: 9.27–11.21%) and urban areas the lowest (4.25%, 95% CI: 3.72–4.78%).

Sport engagement and dietary patterns

Table 2 presents a comprehensive overview of dietary habits and physical activity patterns among the study population, highlighting both sexes differences and overall trends across various weight-related factors. Most children $n = 10{,}421$ (82%) reported always actively commuting to school, with no significant sex difference ($p = 0.270$). Notably, boys had a significantly higher engagement in weekly SPA three or more times per week $n = 2{,}689$ (42%) compared to girls ($n = 1{,}877$, 30%, $p < 0.001$). Additionally, girls reported also a significant lack of regularity in weekly SPA ($n = 4{,}082$, 66%) compared to boys ($n = 3{,}318$, 52%, $p < 0.001$).

The majority of children $n = 10{,}542$ (83%) reported consuming three or fewer meals per day, with no significant sex differences ($p = 0.083$). Interestingly, $n = 6{,}673$ (53%) children consumed half a plate of grains or starch per

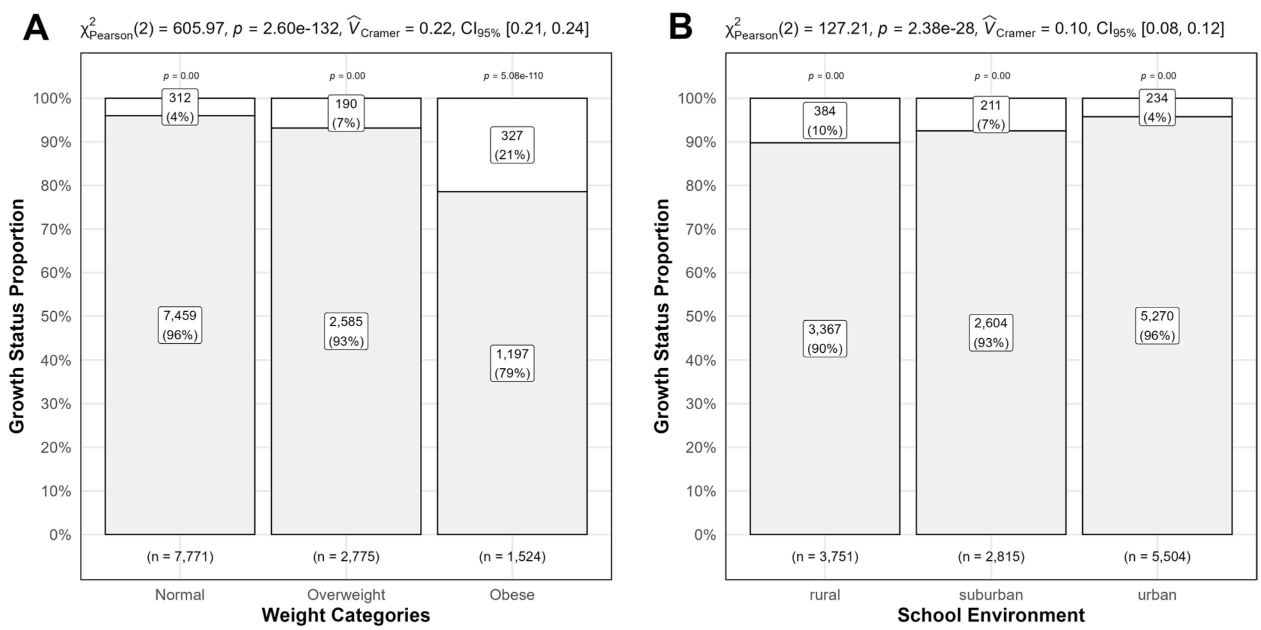

Fig. 3 Prevalence of stunting among schoolchildren by (**A**) weight status and (**B**) school environment. Statistical tests indicate a strong association between stunting and weight categories ($\chi^2 = 605.97$, $p < 0.001$, Cramer's $V = 0.22$) and a weaker association with school environment ($\chi^2 = 127.21$, $p < 0.001$, Cramer's $V = 0.10$). White portions represent stunted children; gray represents normal growth. P-values for pairwise comparisons between categories are displayed above each column, with highly significant differences ($p < 0.001$)

Table 2 Sex-specific physical activity and dietary habits patterns among primary schoolchildren in Bejaia Province, Algeria

Characteristics	Overall, $N=12,655$	Boys, $N=6,438$	Girls, $N=6,217$	p-value
Active commuting to School				0.270
Always	10,421 (82%)	5,326 (83%)	5,095 (82%)	
Rarely	2,230 (18%)	1,111 (17%)	1,119 (18%)	
Weekly SPA				<0.001
≥3 times	4,566 (36%)	2,689 (42%)	1,877 (30%)	
1 time	8,086 (64%)	3,748 (58%)	4,338 (70%)	
Regularity of Weekly SPA				<0.001
No	7,400 (58%)	3,318 (52%)	4,082 (66%)	
Yes	5,250 (42%)	3,118 (48%)	2,132 (34%)	
Number of Meals				0.083
≤3 meals	10,542 (83%)	5,328 (83%)	5,214 (84%)	
>3 meals	2,110 (17%)	1,110 (17%)	1,000 (16%)	
Grains & starch portion per Meal				<0.001
1/4 plate	3,165 (25%)	1,613 (25%)	1,552 (25%)	
1/2 plate	6,673 (53%)	3,287 (51%)	3,386 (54%)	
> 1/2 plate	2,817 (22%)	1,538 (24%)	1,279 (21%)	
Convenience Food				0.003
>3 per week	3,252 (26%)	1,727 (27%)	1,525 (25%)	
≤1 per week	9,391 (74%)	4,707 (73%)	4,684 (75%)	
Snacking between meals				0.527
No	7,795 (62%)	3,927 (61%)	3,868 (62%)	
Yes	4,858 (38%)	2,511 (39%)	2,347 (38%)	
Milk consumption				0.066
1 cup per day	6,036 (48%)	3,025 (47%)	3,011 (48%)	
2 cups per day	5,795 (46%)	2,967 (46%)	2,828 (46%)	
≥3 cups per day	816 (6.5%)	443 (6.9%)	373 (6.0%)	
Cheese consumption				0.304
Daily consumers	6,057 (48%)	3,111 (48%)	2,946 (47%)	
≤2 per week	6,587 (52%)	3,323 (52%)	3,264 (53%)	
Bakery Products				0.269
>3 per week	908 (7.2%)	478 (7.4%)	430 (6.9%)	
≤3 times per week	11,740 (93%)	5,957 (93%)	5,783 (93%)	
Sugary Beverages				0.707
High (daily)	6,672 (53%)	3,384 (53%)	3,288 (53%)	
Moderate (≥3 per week)	5,974 (47%)	3,050 (47%)	2,924 (47%)	
Fast food consumption				<0.001
>1 per week	410 (3.2%)	258 (4.0%)	152 (2.4%)	
≤1 per week	12,236 (97%)	6,177 (96%)	6,059 (98%)	

Values are presented as absolute counts (percentage). *P*-values were calculated using Pearson's Chi-squared test

meal, with a significantly higher prevalence among girls ($p<0.001$). Convenience food consumption was relatively low $n=3,252$ (26%) but slightly higher in boys $n=1,727$ (27%) compared to girls ($p=0.003$). There was no significant sex differences observed for several other dietary habits: more than half of the children ($n=6,672$, 53%) reported high consumption of sugary beverages ($p=0.707$), while the majority did not engage in frequent consumption of bakery products ($n=908$, 7.2%, $p=0.269$) or processed foods (not provided in table, $p=0.304$). Similarly, milk and cheese consumption followed this pattern, with only $n=816$ (6.5%) children drinking three or more cups of milk per day ($p=0.066$), and $n=6,057$ (48%) being daily consumers of cheese ($p=0.304$), both without notable sex differences. However, fast food consumption exhibited a significant sex disparity ($p<0.001$), with boys more likely to consume fast food more than once per week $n = 258$ (4.0%) compared to girls $n = 152$ (2.4%).

Figure 4 illustrates the proportional patterns of schoolchildren's snack choices, categorized into four NOVA groups. Schoolchildren showed a clear preference for ultra-processed foods, which constitute 66.5% of all snack choices followed by processed foods 24.6% of the snacks. In contrast, unprocessed or minimally processed foods contribute only 7.6% of the total, while processed culinary ingredients (e.g., butter) account for a minimal proportion at 1.3%.

Factors associated with obesity/overweight prevalence

Age, sex, growth status and environment

Table 3 presents the associations between various factors and overweight/obesity prevalence among children aged 9–13 years, stratified by sex. A consistent trend indicated a reduction in children's likelihood of being overweight or obese with increasing age. Specifically, for each year increase in age, the odds of overweight or obesity decreased significantly for both boys (aOR = 0.72, 95% CI: 0.66 – 0.77, $p < 0.001$) and girls (aOR = 0.75, 95% CI: 0.69 – 0.82, $p < 0.001$).

When considering the environment, children residing in urban areas had significantly higher odds of being overweight or obese compared to those in rural areas, with similar effects in both boys (aOR = 1.58, 95% CI: 1.39 – 1.81, $p < 0.001$) and girls (aOR = 1.30, 95% CI: 1.14 – 1.49, $p < 0.001$). Additionally, suburban residence was significantly associated with increased odds of overweight/obesity in boys (aOR = 1.57, 95% CI: 1.35 – 1.84, $p < 0.001$), while in girls this association was not statistically significant (aOR = 1.05, 95% CI: 0.90 – 1.23, $p = 0.5$).

Interestingly, children's growth status demonstrated a strong positive association with overweight/obesity. Stunted children had markedly higher odds of being overweight or obese, with the effect being more pronounced in boys (aOR = 5.78, 95% CI: 4.41–7.66, $p < 0.001$) compared to girls (aOR = 3.42, 95% CI: 2.77–4.26, $p < 0.001$).

Dietary habits and physical activity

For dietary habits, consuming more than three meals daily was protective for both boys (aOR = 0.84, 95% CI: 0.72 – 0.98, $p = 0.023$) and girls (aOR = 0.79, 95% CI: 0.67 – 0.93, $p = 0.004$), while eating between meals had the opposite effect, significantly increasing the likelihood of having overweight/obesity in both boys (aOR = 1.16, 95% CI: 1.01 – 1.32, $p = 0.032$) and girls (aOR = 1.19, 95% CI: 1.05 – 1.36, $p = 0.008$). Similarly, consuming meals with more than half plate of grain/starch portion increased the risk of having overweight/obesity in both boys (aOR = 1.48, 95% CI: 1.29 – 1.71, $p < 0.001$) and girls (aOR = 1.21, 95% CI: 1.05 – 1.40, $p = 0.008$). Notably, fast food consumption frequency demonstrated sex differences, with limited consumption (≤ 1 per week) showing a strong protective effect for boys (aOR = 0.58, 95% CI: 0.43 – 0.77, $p < 0.001$) but no significant effect for girls.

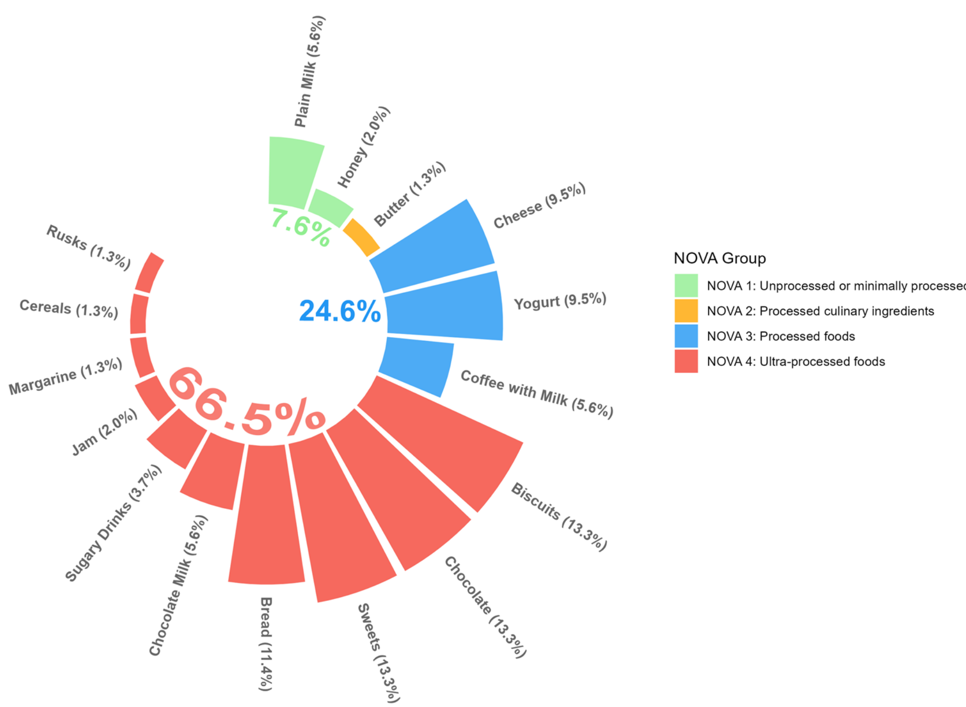

Fig. 4 Observed patterns in schoolchildren's snack choices

Table 3 Crude and adjusted odds ratios for factors associated with overweight/obesity among schoolchildren in Bejaia Province, Algeria; Results are presented with 95% confidence intervals (CI) from univariate (crude) and multivariable logistic regression (adjusted) models

Boys	Unadjusted ORs			Adjusted ORs		
Characteristics	OR	95% CI	p-value	OR	95% CI	p-value
Age	0.75	0.69, 0.80	< 0.001	0.72	0.66, 0.77	< 0.001
School environment						
Rural	*Ref*	—	—	*Ref*	—	—
Suburban	1.43	1.24, 1.66	< 0.001	1.57	1.35, 1.84	< 0.001
Urban	1.45	1.28, 1.64	< 0.001	1.58	1.39, 1.81	< 0.001
Growth status						
Normal	*Ref*	—	—	*Ref*	—	—
Stunted	5.08	3.91, 6.70	< 0.001	5.78	4.41, 7.66	< 0.001
Active commuting to School						
Always	*Ref*	—	—	*Ref*	—	—
Rarely	1.61	1.40, 1.85	< 0.001	1.48	1.27, 1.72	< 0.001
Weekly SPA						
1 time	*Ref*	—	—	*Ref*	—	—
≥ 3 times	*0.76*	0.68, 0.85	< 0.001	0.81	0.72, 0.91	< 0.001
Regularity of Weekly SPA						
No	*Ref*	—	—	*Ref*	—	—
Yes	0.77	0.69, 0.86	< 0.001	0.82	0.73, 0.92	< 0.001
Number of Meals						
≤ 3 meals	*Ref*	—	—	*Ref*	—	—
> 3 meals	0.87	0.75, 1.00	0.045	0.84	0.72, 0.98	0.023
Grains & starch portion per Meal						
1/2 plate	*Ref*	—	—	*Ref*	—	—
1/4 plate	1.05	0.92, 1.20	0.5	0.98	0.86, 1.13	0.8
> 1/2 plate	1.39	1.22, 1.59	< 0.001	1.48	1.29, 1.71	< 0.001
Snacking between meals						
No	*Ref*	—	—	*Ref*	—	—
Yes	1.07	0.95, 1.21	0.3	1.16	1.01, 1.32	0.032
Fast food consumption						
> 1 per week	*Ref*	—	—	*Ref*	—	—
≤ 1 per week	0.62	0.47, 0.82	< 0.001	0.58	0.43, 0.77	< 0.001
Girls	**Unadjusted ORs**			**Adjusted ORs**		
Characteristics	**OR**	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Age	0.78	0.72, 0.85	< 0.001	0.75	0.69, 0.82	< 0.001
School environment						
Rural	*Ref*	—	—	*Ref*	—	—
Suburban	0.95	0.82, 1.10	0.5	1.05	0.90, 1.23	0.5
Urban	1.17	1.03, 1.33	0.014	1.30	1.14, 1.49	< 0.001
Growth status						
Normal	*Ref*	—	—	*Ref*	—	—
Stunted	3.07	2.50, 3.79	< 0.001	3.42	2.77, 4.26	< 0.001
Active commuting to School						
Always	*Ref*	—	—	*Ref*	—	—
Rarely	1.23	1.07, 1.41	0.004	1.14	0.99, 1.32	0.076
Weekly SPA						
1 time	*Ref*	—	—	*Ref*	—	—
≥ 3 times	0.88	0.78, 0.99	0.035	0.95	0.84, 1.08	0.5

Table 3 (continued)

Girls	Unadjusted ORs			Adjusted ORs		
Characteristics	OR	95% CI	p-value	OR	95% CI	p-value
Regularity of Weekly SPA						
No	*Ref*	—	—	*Ref*	—	—
Yes	0.78	0.69, 0.87	< 0.001	0.78	0.69, 0.88	< 0.001
Number of Meals						
≤ 3 meals	*Ref*	—	—	*Ref*	—	—
> 3 meals	0.83	0.71, 0.97	0.016	0.79	0.67, 0.93	0.004
Grains & starch portion per Meal						
1/2 plate	*Ref*	—	—	*Ref*	—	—
1/4 plate	1.05	0.92, 1.20	0.5	1.04	0.91, 1.19	0.6
> 1/2 plate	1.15	1.00, 1.31	0.052	1.21	1.05, 1.40	0.008
Snacking between meals						
No	*Ref*	—	—	*Ref*	—	—
Yes	1.24	0.90, 1.72	0.2	1.29	0.92, 1.80	0.14
Fast food consumption						
> 1 per week	*Ref*	—	—	*Ref*	—	—
≤ 1 per week	1.12	0.99, 1.27	0.077	1.19	1.05, 1.36	0.008

Active commuting to school showed a significant association with overweight/obesity in boys, with those rarely walking to school having higher odds of having overweight/obesity (aOR = 1.48, 95% CI: 1.27 – 1.72, $p < 0.001$) compared to those who always walk. This association was not statistically significant for girls (aOR = 1.14, 95% CI: 0.99 – 1.32, $p = 0.076$). Moreover, boys engaging in sports three or more times weekly had lower odds of having overweight/obesity compared to those exercising once a week (aOR = 0.81, 95% CI: 0.72 – 0.91, $p < 0.001$), while this effect was not statistically significant for girls (aOR = 0.95, 95% CI: 0.84 – 1.08, $p = 0.5$). Regular weekly SPA was protective for both sexes, with similar effects in boys (aOR = 0.82, 95% CI: 0.73 – 0.92, $p < 0.001$) and girls (aOR = 0.78, 95% CI: 0.69 – 0.88, $p < 0.001$).

Discussion

The rising prevalence of childhood overweight and obesity in Algeria outlines an urgent public health challenge. While global and regional trends highlight this growing concern, data specific to Algerian schoolchildren remain scarce. This study provides valuable insights by examining the prevalence of overweight, obesity (severe obesity included), and stunting, as well as their associations with dietary habits, physical activity, and the school environment. To the best of our literature search, this is the first study that has assessed the epidemiological dynamics and determinants of childhood overweight and obesity in Algeria over a large number of schoolchildren.

The current study involved a substantial sample size of primary school pupils from Bejaia province in northern Algeria, ensuring a considerable representation of the population. The average weight and height of the children were within the expected range for their age group, with boys showing slightly higher average weights and heights than girls. This aligns with general growth patterns observed globally as per the WHO's growth curves for children aged 5–19 years, suggesting that children's anthropometrics of the study's region are representative of normal growth curves [37]. On a local scale however, children aged 9 and 10 in Bejaia exhibited significantly lower BMI values compared to those in Constantine Province (another Algerian Province located in northeastern Algeria), with notable sex differences. At age 9, girls and boys in Bejaia had BMI values of 20 and 20.1, respectively, which were 39–41% lower than those in Constantine (32.66 for girls and 33.94 for boys). Similarly, at age 10, Bejaia's children showed BMI values of 18.5 for both sexes, representing a 49–53% reduction compared to Constantine's 36.38 for girls and 38.98 for boys [38]. This notable disparity between the two Algerian provinces can be attributed to several factors, including differences in sample size between the studies, which could influence the representativeness and variability of the data. Additionally, regional differences in lifestyle, dietary habits, and environmental factors may contribute to these variations [39]. Particularly, the distinct Kabyle culinary practices prevalent in Bejaia could play an important role; further research is needed to explore this aspect in detail.

The recorded prevalence rates of overweight obesity in our study are consistent with trends observed in other Mediterranean region, although some notable differences exist. For instance, in Spain, overweight and obesity prevalence among children aged 5 to 14 was reported at 26% and 9%, respectively [40] which shows a 4% higher overweight prevalence and a similar obesity rate compared to our findings. However, the largest discrepancy appears in the Italian side, where 39% of children aged 8 to 9 were classified as overweight or obese which is 17% higher prevalence of overweight/obesity than what we observed in the current study [41]. In contrast, Moroccan schoolchildren reported much lower rates of overweight and obesity, with prevalence approximately 2.7 times lower compared to our study [42]. These differences may be attributed to several factors, such as differences in dietary habits, the degree of urbanization, and socio-economic conditions across the regions. In Spain and Italy, a shift towards highly processed, calorie-dense foods combined with sedentary lifestyles may contribute to higher obesity rates, particularly in more urbanized environments [43, 44]. In contrast, Morocco's lower rates may be associated with more traditional dietary patterns [45]. The socio-economic context, including healthcare access and public health initiatives, likely also plays a critical role in shaping these regional differences [46]. In the Algerian context, several specific factors may explain our intermediate position in regional obesity prevalence. Algeria's ongoing nutrition transition represents a blend of traditional Mediterranean dietary patterns and increasing Western influence, particularly in urban areas [47]. Unlike Spain and Italy, which experienced this transition earlier, Algeria is in a more recent phase, potentially explaining our lower rates compared to these European countries. Additionally, government food subsidies on staple items, which differ from policies in neighboring countries, may also influence nutritional patterns; Algerian food subsidies policies help in stabilizing food prices and ensure staple foods remain affordable despite international market fluctuations. While these subsidies support food security, especially for low-income households, they may simultaneously influence consumption patterns by increasing the accessibility of calorie-dense staple foods like wheat products and oils. This dual effect of subsidies—providing nutritional safety while potentially encouraging higher consumption of certain energy-dense foods—may contribute to the intermediate obesity rates observed in our study [48].

The higher prevalence of obesity (severe obesity included) among boys compared to girls, observed in our study aligns with global trends reported in the literature [49, 50]. Several factors may contribute to these sex-specific differences. Hormonal activity, the onset of puberty, and any disruptions in these processes can impact weight gain, as well as fat distribution and metabolism [51]. Behavioral factors, such as differences in physical activity levels and dietary preferences between boys and girls, also play a significant role [52]. The decreasing trend of overweight, obesity, and severe obesity with age observed in both sexes which is largely in accordance with prior studies [50], suggests that early adolescence may be a critical period for the onset of these conditions. This pattern may be explained by changes in physical activity and dietary habits as children grow older and become more independent in their food choices. Additionally, as boys and girls approach puberty, the hormone shifts could partially contribute to this decreasing trend [53]. Besides, teenagers often become more conscious of their appearance, which leads them to put more effort into controlling their weight [50]. Interestingly, the study findings showed association between stunting and overweight-obesity prevalence in schoolchildren, with stunted children exhibiting notably higher odds of being overweight or obese. This seemingly paradoxical association, often referred to as the 'double burden of malnutrition,' has been reported in various settings, particularly in low- and middle-income countries undergoing nutrition transitions. In these contexts, rapid shifts towards more calorie-dense, nutrient-poor diets, combined with sedentary lifestyles, can lead to a situation where children suffer from both undernutrition (manifesting as stunting) and overnutrition (leading to overweight/obesity)[17, 19, 20]. The school environment variation also revealed a significant association between overweight—obesity prevalence and urban schooling for both sexes. Higher rates of overweight and obesity in urban and suburban schools could be attributed to greater access to high-calorie, processed foods, and lower levels of physical activity due to sedentary lifestyles. These findings are in accordance with those reported by Hadri, Benada [7] in the region of Relizane Province (western Algeria) among primary schoolchildren. Conversely, the higher prevalence of severe obesity in rural areas suggests that while the overall rates may be lower, the cases that do occur are more severe, potentially due to delayed detection and limited access to healthcare services.

While physical activity is crucial for overall health, its role in combating obesity among children is not as clear-cut as previously thought [54, 55]. The study's findings identified a concerning trend regarding SPA engagement among the schoolchildren. Most children engaged in SPA only once per week, with mostly irregular participation being prevalent. The World Health Organization (WHO) recommends that children aged 5–17 years should engage in at least 60 min of moderate-to-vigorous-intensity physical activity daily, incorporating vigorous-intensity aerobic activities, as well as those that strengthen muscle and bone, at least three days a week [56]. Boys were more engaged into SPA than girls, suggesting a sex disparity which is consistent with other studies that report sex differences in SPA engagement among children [57, 58]. This difference in engagement levels could be attributed to various social, cultural, and psychological factors [59, 60]; for example, boys often receive more encouragement to participate in competitive and vigorous activities, which are culturally associated with masculinity, while girls might be encouraged to engage in less intense, more aesthetic or cooperative activities. Moreover, boys might have more access to opportunities for vigorous play and sports, both at school and in extracurricular settings [59]. The recorded significant associations between physical activity patterns — active commuting to school and regular weekly SPA engagement — and the reduced likelihood of being overweight or obese for school children suggest that consistent physical activity could have a protective effect, particularly when such activities are part of regular routines. Strategies to promote regular physical activity might need to be tailored to address specific barriers faced by boys and girls. This is particularly relevant in contexts where irregular participation prevails, emphasizing the importance of creating environments that facilitate and encourage daily physical activity as recommended by health guidelines.

Dietary habits in childhood have a major role in shaping long-term health outcomes, particularly in relation to obesity and stunting [61]. Linking meal frequency to obesity remain inconclusive [62]. Surprisingly, eating over 3 meals daily was associated with lower overweight—obesity risk, possibly due to the benefits of frequent small meals versus fewer large ones [63]. The study findings also showed that schoolchildren who consumed more than half of their plate in starches and grains had higher odds of being overweight or obese compared to those with more balanced portions. Starchy foods, especially refined grains, are often energy-dense but low in nutrients. A diet heavy in starches can lead to excess calorie intake and weight gain [64]. This pattern is closely linked to the type of snacks consumed, with over 80% in this study classified as processed or ultra-processed foods, including biscuits, sweets, and sugary beverages. Fast food and processed/ultra-processed snacks are typically high in unhealthy fats, sugars, and calories, contributing to poor nutritional quality and excessive caloric intake. The frequent consumption of these foods—whether as meals or snacks—creates a dietary pattern that is strongly associated with obesity and other related health risks [29].

Strengths and limitations

Certain limitations should be acknowledged. Firstly, the self-reported nature of dietary habits and physical activity introduces the possibility of reporting bias, which may affect data accuracy. Additionally, while our study employed LASSO regression to enhance model parsimony and prevent overfitting, the process of variable selection was based on statistical contribution rather than explicit consideration of confounding effects. Although we adjusted for multiple known risk factors, the possibility of residual confounding remains, as some important unmeasured variables (e.g. birth weight, parental education, and household food insecurity) were not included in the final model.

Nevertheless, our study's large sample size and high participation rate strengthen the reliability of our findings. The strong associations observed between weight status and factors such as age, growth status, school environment, and selected weight-related variables offer valuable insights into obesity patterns among Algerian primary schoolchildren. These results contribute meaningful evidence to inform targeted public health interventions for childhood obesity prevention.

Conclusion

This study provides valuable insights into the prevalence and determinants of obesity among primary schoolchildren in Bejaia province, Algeria. The high prevalence of obesity and its strong associations with physical inactivity and dietary habits highlight the urgent need for public health interventions. Promoting regular physical activity, healthy eating habits, and addressing environmental factors are critical steps towards curbing this health issue in this region. Future research should build upon these findings by including a broader age and geographical (multiple Provinces) range of children and incorporating additional measures that could address our noted limitations, such as birth weight, parental education, and household food insecurity. These extensions would offer a holistic understanding of the factors influencing childhood obesity in this population.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1186/s41110-025-00342-6.

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Author contribution SZ led the research project and supervised the overall research process. MK critically supervised the research project. MKM conducted the statistical analysis and drafted the manuscript. ZM, LM, YB, KM, and Zahia Brara contributed to data curation and manuscript review. BZ and MA were responsible for data collection and provided official school categorization data. SB, NM, AA and SB assisted in manuscript revision. All authors reviewed and approved the final manuscript draft and agreed to be accountable for all aspects of the work.

Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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