



Revista Española de Nutrición Humana y Dietética

Spanish Journal of Human Nutrition and Dietetics

INVESTIGATION – **versión post-print**

Esta es la versión aceptada para publicación. El artículo puede recibir modificaciones de estilo y de formato.

Healthy vs. Unhealthy Snacks: Impact on Obesity Risk Among Mexican Adolescents. Results from a cross-sectional study.

Snacks saludables Vs snacks no saludables: impacto en el riesgo de obesidad entre adolescentes mexicanos. Resultados de un estudio transversal.

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Received: 28/04/2025; Accepted: 27/02/2026; Published: 10/05/2026.

Editor Asignado: Rafael Almendra-Pegueros, Institut de Recerca Sant Pau (IR SANT PAU), Barcelona, Spain.

CITE: Castrejón Barajas MG, Aguilera Cervantes VG, Ezzahra Housni F, Herrera-Meza A, Lares-Michel M, Righini N, Ochoa N, Florian López JA. Healthy vs. Unhealthy Snacks: Impact on Obesity Risk Among Mexican Adolescents. Results from a cross-sectional study. Rev Esp Nutr Hum Diet. 2026; 30(2). doi: 10.14306/renhyd.30.2.2467 [ahead of print].

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ABSTRACT

Background: Snacking during adolescence has been identified as both a risk and a protective factor for obesity. The type, frequency, and quantity of snack intake may determine their health impact. This study evaluated school snack intake by type (healthy vs. unhealthy) and its association with obesity risk.

Methods: A Snack and Beverage Frequency Questionnaire (SBFQ) was adapted and applied to 397 Mexican adolescents aged 15–18 years. Snack intake was estimated in grams and compared according to BMI-for-age z-score categories (adequate vs. excess weight). BMI-for-age z-score was correlated with adiposity indicators using Spearman's coefficient. For regression analyses, snack variables were dichotomized (0/1) based on daily portion recommendations. Multivariable Poisson regression models with robust standard errors were adjusted for age and sex.

Results: BMI-for-age z-score showed strong positive correlations with waist circumference, hip circumference, waist-to-height ratio, and body fat percentage (all $p < 0.001$). No significant associations were observed between healthy snack intake and excess weight. Among unhealthy snacks, sweet bread intake was significantly associated with BMI-for-age category (IRR = 0.67; 95% CI: 0.49–0.91; $p = 0.011$), while other snack categories showed no significant associations.

Conclusion: In this sample of Mexican adolescents, snack intake classified according to daily portion recommendations was not consistently associated with obesity risk. These findings suggest that isolated snack consumption during school hours may have limited impact on BMI when total dietary intake is not assessed. Comprehensive evaluation of overall dietary patterns may be necessary to better understand the role of snacks in adolescent obesity.

Keywords: Snack; snacking behavior; obesity risk; Mexican adolescents.

RESUMEN

Introducción: El consumo de refrigerios (snacks) durante la adolescencia se ha identificado tanto como un factor de riesgo como un factor protector frente a la obesidad. El tipo, la frecuencia y la cantidad de los refrigerios consumidos pueden determinar su impacto en la salud. Este estudio evaluó la ingesta de refrigerios escolares según su tipo (saludables vs. no saludables) y su asociación con el riesgo de obesidad.

Métodos: Se adaptó y aplicó un Cuestionario de Frecuencia de Consumo de Refrigerios y Bebidas (SBFQ) a 397 adolescentes mexicanos de 15 a 18 años de edad. El consumo de snacks se estimó en gramos y se comparó según categorías de IMC para la edad (adecuado vs. exceso de peso). El puntaje z de IMC para la edad se correlacionó con indicadores de adiposidad mediante el coeficiente de Spearman. Para los análisis de regresión, las variables de snacks se dicotomizaron (0/1) con base en recomendaciones de porción diaria. Se realizaron modelos de regresión de Poisson multivariados con errores estándar robustos, ajustados por edad y sexo.

Resultados: El puntaje z de IMC para la edad mostró correlaciones positivas fuertes con circunferencia de cintura, circunferencia de cadera, relación cintura-talla y porcentaje de grasa corporal (todos $p < 0.001$). No se observaron asociaciones significativas entre el consumo de snacks saludables y el exceso de peso. En el caso de los snacks no saludables, el consumo de pan dulce se asoció significativamente con la categoría de IMC para la edad (IRR = 0.67; IC95%: 0.49–0.91; $p = 0.011$), mientras que las demás categorías no mostraron asociaciones significativas.

Conclusión: En esta muestra de adolescentes mexicanos, el consumo de snacks clasificado según recomendaciones de porción diaria no se asoció de manera consistente con el riesgo de obesidad. Estos hallazgos sugieren que el consumo aislado de snacks durante el horario escolar podría tener un impacto limitado sobre el IMC cuando no se evalúa la ingesta total diaria. La evaluación integral de los patrones dietéticos podría ser necesaria para comprender mejor el papel de los snacks en la obesidad adolescente.

Palabras clave: Refrigerios; comportamiento alimentario; riesgo de obesidad; adolescentes mexicanos.

KEY MESSAGES

- The BMI-for-age z-score showed a strong correlation with indicators of central adiposity, supporting its use as a primary risk variable for obesity in adolescents.
- No consistent associations were observed between the consumption of healthy snacks, categorized by recommended daily servings, and excess weight.
- Although most unhealthy snacks were not significantly associated with excess weight in the adjusted models, significant differences were observed in the consumption of sweets

and chocolates across BMI categories, and the consumption of sweet bread showed an association in the Poisson regression model.

- Assessing only snack consumption during school hours may be insufficient to explain the risk of obesity; the overall dietary pattern must be considered.

INTRODUCTION

Obesity is one of the principal public health problems nowadays, both in developed and developing countries, and it affects the population throughout different life stages¹. In particular, obesity at an early age, such as the adolescence period (i.e., pediatric obesity), is a worrying problem worldwide^{1,2}. Body weight is controlled by a combination of energy homeostasis, cognitive-emotional processes, and a multifactorial interaction of intricate regulatory circuits³. Pediatric obesity emerges as a result of the disruption of regulatory processes by multiple environmental factors, encompassing preconception and prenatal exposures, along with broader alterations in food and physical activity environments. These influences are currently pervasive across most countries¹.

Adolescence is a critical stage of life during which new eating behaviors are acquired or previously established behaviors are reinforced and maintained or increased⁴. Moreover, the school environment plays an important role in adolescents' eating behavior⁵. In the school environment, snack consumption has been considered one of the main contributors to overweight due to the increased consumption of energy-dense, high-sugar, and fat foods⁶. However, the definition of a snack is heterogeneous throughout the literature. Various authors point out this term as any type of food, solid or liquid, consumed between the three main meals of the day (breakfast, lunch, and dinner) that does not replace one of these^{7,8}. From a nutritional perspective, snacks can have different quality and nutritional profiles; therefore, a snack does not necessarily correspond to ultra-processed foods. Some authors have addressed the terms of "recommended" or "not recommended" foods under the concept of healthy or unhealthy foods^{9,10}. Generally, fruits, vegetables, nuts, or prepared food with low fat and high fiber content are considered healthy snacks. Healthy beverages in the context of snacks are mainly natural water or non-sugary drinks. On the other hand, ultra-processed foods, such as cookies, chips, ice cream, and high-sugar

and/or fat foods such as candy bars are considered unhealthy snacks. Unhealthy beverages are principally sugary drinks^{10,11}.

Currently, Mexico leads the first place in pediatric obesity internationally with a prevalence of 36.6% in scholars and 40.1% in adolescents¹². The country's obesogenic environment has been repeatedly referred to as one of the leading causes of this situation. As possible solutions, sugar tax policies and new warning labeling in ultra-processed food have been implemented. Besides, policies for regulating the sale of ultra-processed food in schools have been established and implemented¹³. Nevertheless, several schools do not comply with these regulations, and nowadays, several ultra-processed foods are available for purchase in most Mexican schools, especially in small cities and towns, both in rural and urban areas. In addition, healthy snack options tend to be limited or, in some cases, unavailable. However, to the best of our knowledge, no previous study has explored the association between consuming healthy or unhealthy snacks and beverages and the development of obesity. Therefore, the objective of this study was to evaluate the intake of school snacks according to their type (healthy and unhealthy) and to analyze their association with obesity risk.

MATERIAL AND METHODS

Study design, sample socioeconomic and demographic characteristics

An observational, analytical, cross-sectional study was conducted among 397 high school students (59% female) aged 15–18 from the Preparatoria Regional de Tuxpan, Jalisco, Mexico. Inclusion criteria were being Mexican and a regular student; those under medical or nutritional treatment were excluded. Sample size was determined using a probabilistic formula for finite populations ($n = 260$ minimum)¹⁴.

Procedure and ethical aspects

School authorities and families were informed through videos about the study's objectives and procedures. Written informed consent and assent were obtained. The study was approved by the Ethics and Technical Committees of CUSUR, University of Guadalajara (CEI/058/2022; CIP/T/0922), and conducted in accordance with the Declaration of Helsinki.

Snacks intake assessment and classification

School snacks were defined as any food or beverage consumed ≥ 30 minutes after a main meal without replacing it^{7,8}. A Snack and Beverage Frequency Questionnaire (SBFQ)¹⁵ was adapted from validated tools¹⁶ and applied by a trained nutritionist using visual aids ([Supplementary Material 1](#)). Snacks were classified as healthy or unhealthy according to Mexican dietary guidelines⁹, with detailed criteria, frequency conversions, and portion sizes described in [Supplementary Material 2](#). Daily intake in grams was calculated from reported frequency and standardized portions using the Mexican Food Exchange System¹⁷.

Anthropometric and body composition evaluation and classification

Height and weight were measured using a Seca[®] 213 stadiometer and Omron[®] HBF-514c bioimpedance device. Waist and hip circumference were assessed with a Lufkin[®] metal tape. BMI for age (according to z score¹⁸), body fat percentage¹⁹, waist circumference²⁰, waist-to-hip ratio²¹, and waist-height ratio²² were calculated and classified following standardized procedures. BMI-for-age z-score was used as the primary outcome variable in the analytical models. Detailed classification criteria, cut-off points, and prevalence estimates for all adiposity indicators are provided in [Supplementary Material 3](#) for descriptive and methodological transparency.

Statistical analyses

Data normality was assessed using the Kolmogorov–Smirnov test, which indicated a non-normal distribution of continuous variables. Therefore, descriptive statistics are presented as medians and interquartile ranges (IQR). Nutritional status was defined using BMI-for-age z-scores according to established international cut-offs¹⁸. BMI-for-age z-score was the primary outcome variable in all analyses. To assess its consistency with other adiposity indicators, BMI-for-age z-score was correlated with body fat percentage, waist circumference, hip circumference, waist-to-hip ratio, and waist-to-height ratio using Spearman's rank correlation coefficient.

Snack intake, expressed in grams, was compared between BMI-for-age z-score categories classified as adequate (underweight and normal weight) and excess weight (overweight and obesity) using the Mann–Whitney U test. Categorical variables were analyzed using the chi-squared test. Cut-off points used to define nutritional status and body composition indicators are presented in [Supplementary Table SM3.1](#).

Multivariable Poisson regression models with robust standard errors were performed to examine the association between snack intake and BMI-for-age z-score categories. BMI-for-age category (adequate vs. excessive) was the sole dependent variable in the regression analyses. All models were adjusted for age and sex²³.

For regression analyses only, snack variables were dichotomized (0/1) according to daily dietary recommendations detailed in [Supplementary Table SM2.1. and SM2.2.](#) For unhealthy snacks, intake was coded as 1 (risk exposure) when consumption reached or exceeded one portion per day, and 0 otherwise. For healthy snacks, intake was coded as 1 (risk exposure) when consumption was below one portion per day, and 0 otherwise.

For healthy snacks (fruits, vegetables, nuts, dried fruits, and water), recommendations were based on World Health Organization guidelines (WHO)^{24,25} and Mexican dietary guidelines²⁶, and were adapted according to the Mexican System of Food Equivalents (SMAE)¹⁷. For example, WHO recommends at least 400 g/day of fruits and vegetables; however, given that total daily intake was not assessed and only snack consumption was evaluated, intake of ≥ 1 portion (e.g., approximately 80 g of fruits or vegetables) was operationally considered as meeting a minimum protective threshold for snack consumption.

For unhealthy snacks, the general recommendation is to avoid their consumption. However, Mexican dietary guidelines allow up to three portions of sugars per day for adolescents aged 15–18 years²⁶. Based on portion equivalents, consumption of ≥ 1 portion of unhealthy snacks (e.g., sweet bread, sugary drinks, chips, or confectionery) may substantially contribute to or exceed this recommended sugar allowance¹⁷. Therefore, intake of one or more portions per day of unhealthy snacks was classified as risk exposure^{27,28}.

Because total daily dietary intake was not evaluated and the objective of the study was not to assess overall diet quality, one portion per day was used as a pragmatic operational threshold for dichotomization. This approach allowed standardization of exposure variables without assuming complete dietary assessment^{27,28}. All statistical analyses were conducted using STATA version 12 (StataCorp, College Station, TX, USA). Statistical significance was set at $p \leq 0.05$.

RESULTS

Socioeconomic and anthropometric characteristics of the sample

Table 1 shows the sociodemographic and anthropometric characteristics of the population. A total of 397 adolescents were included in the analysis. Girls comprised 59.2% of the sample (n = 235) and boys 40.8% (n = 162) (p < 0.001). Most participants lived in urban areas (81.1%), followed by rural areas (18.8%) (p < 0.001). According to BMI-for-age z-score classification, 59.2% of participants had normal weight, 14.6% were overweight, and 24.2% were obese, while 2.0% were underweight (p < 0.001). Overall, 38.8% of the adolescents were classified as having excess weight (overweight or obesity) based on BMI-for-age criteria.

Table 1. Sociodemographic characteristics and BMI-for-age categories of the study population (n = 397)

	n	%	p value
	397	100	
Sex			
Girls	235	59.19	<0.0001
Boys	162	40.81	
Residential zone			
Atenquique (rural area)	11	2.77	<0.0001
Platanar, San Marcos and Tonila (rural area)	64	16.12	
Tuxpan (urban area)	322	81.11	
Body Mass Index for Age (z score)			
Underweight	8	2.02	<0.0001
Normal weight	235	59.19	
Overweight	58	14.61	
Obese	96	24.18	

Note: p-value obtained from Chi-squared test.

Anthropometric and body composition characteristics of the sample

Table 2 presents the anthropometric and body composition characteristics of the study population. The median age of participants was 16 years (IQR: 1). Median height and weight were 1.64 m (IQR: 0.12) and 59.4 kg (IQR: 18.90), respectively. The median BMI-for-age z-score was 0.55 (IQR: 1.86). Median body fat percentage was 27% (IQR: 13.7). Median waist and hip circumferences were 75 cm (IQR: 15) and 96 cm (IQR: 13), respectively. The median waist-to-hip

ratio (WHR) was 0.77 (IQR: 0.07), and the median waist-to-height ratio (WHtR) was 0.45 (IQR: 0.08). BMI-for-age z-score was strongly correlated with body fat percentage ($\rho = 0.7601$), waist circumference ($\rho = 0.8852$), hip circumference ($\rho = 0.9001$), and waist-to-height ratio ($\rho = 0.9038$) (all $p < 0.0001$). A moderate correlation was observed with waist-to-hip ratio ($\rho = 0.4626$, $p < 0.0001$).

Table 2. Anthropometric and body composition data of the population (n = 397)

Variable	Total population (n = 397)			
	Median	IQR	rho	p-value
Age	16	1	-	-
Height (meters)	1.64	0.12	-	-
Weight (kg)	59.4	18.90	-	-
BMI-for-age z-score	0.55	1.86	-	-
Body Fat (%)	27	13.7	0.7601a	<0.0001
Waist C. (cm)	75	15	0.8852a	<0.0001
Hips C. (cm)	96	13	0.9001a	<0.0001
WHR	0.77	0.07	0.4626a	<0.0001
WHtR	0.45	0.08	0.9038a	<0.0001

Note: C. = Circumference. IQR = Interquartile range. WHR = Waist-Hips Ratio. WHtR = Waist-to-Height Ratio. aSpearman correlation test between BMI-for-age z-score and adiposity indicators. Statistical significance was considered at $p \leq 0.05$. Confidence interval at 95%.

Snack and beverage intake according Body Mass Index for Age (z score)

Table 3 presents snack intake in grams according to BMI-for-age z-score categories. No statistically significant differences were observed between adolescents with adequate BMI and those with excess levels for most snack categories, including water, fruits and vegetables, nuts and dry fruits, quesadillas, total healthy snacks, sugary drinks, sweet bread, chips, and total unhealthy snacks (all $p > 0.05$).

Although differences did not reach statistical significance, adolescents with excess weight showed a tendency toward higher median intake of total unhealthy snacks (475.58 g; IQR: 1060.58) compared to those with adequate BMI (395.31 g; IQR: 760.75), and a lower median intake of total healthy snacks (30.60 g; IQR: 138.72 vs. 37.22 g; IQR: 143.00, respectively). A statistically significant difference was observed only for sweets and chocolates intake ($p =$

0.0014), with adolescents with adequate BMI reporting a higher median intake (13.75 g; IQR: 40.59) compared to those with excess weight (4.35 g; IQR: 24.93).

Table 3. Snack intake in grams according to BMI for age z score

Snack	Body Mass Index for Age (z score)						p-value
	Total population		Adequate (n = 243)		Excessive (n = 154)		
	Median	IQR	Median	IQR	Median	IQR	
Water	1500.00	2600.00	1250.00	2500.00	2500.00	2500.00	0.0725
Fruits and Vegetables	17.83	120.40	20.07	118.13	10.45	120.40	0.2098
Nuts and Dry fruits	0.00	1.15	0.00	1.15	0.00	1.07	0.6623
Quesadillas	2.50	15.00	2.50	15.00	2.50	20.00	0.9694
Total Healthy snacks	32.57	142.28	37.22	143.00	30.60	138.72	0.3813
Sugary drinks	314.00	716.66	308.33	661.33	325.00	1037.50	0.3700
Sweets and Chocolates	8.72	35.17	13.75	40.59	4.35	24.93	0.0014*
Sweet bread	11.93	53.75	11.33	53.21	12.37	51.11	0.8360
Chips	5.33	40.00	10.67	42.67	5.33	32.00	0.1081
Unhealthy snacks	425.85	833.40	395.31	760.75	475.58	1060.58	0.4404

Note: Adequate BMI for age z score = low and normal; Excessive = Overweight and obesity. IQR = Interquartile range.
*p-value between Body Mass Index for Age (z score) categories using the U Mann-Whitney test. Statistical significance was considered at $p \leq 0.05$. Confidence interval at 95%.

Association between snack intake and BMI-for-age z-score categories

Multivariable Poisson regression analyses for healthy snack intake

Table 4 presents the multivariable Poisson regression analysis examining the association between healthy snack intake and BMI-for-age z-score categories. After adjustment for age and sex, no statistically significant associations were observed between intake of water (IRR = 0.85; 95% CI: 0.66–1.10), fruits and vegetables (IRR = 1.08; 95% CI: 0.81–1.44), nuts and dry fruits (IRR = 1.01; 95% CI: 0.64–1.59), or quesadillas (IRR = 0.99; 95% CI: 0.74–1.32) and excess BMI (all $p > 0.05$). The overall model was not statistically significant ($p = 0.7498$; pseudo $R^2 = 0.0033$). Age (IRR = 1.08; 95% CI: 0.94–1.23) and sex (IRR = 0.95; 95% CI: 0.74–1.22) were also not significantly associated with BMI-for-age z-score categories in the adjusted model.

Table 4. Multivariable Poisson regression analysis of BMI-for-age z-score categories according to healthy snack intake

BMI-for-age z score	IRR	Robust SE	z	Pseudo R ² = 0.0033		
				p-value = 0.7498		
				p-value	95% CI	
Water	0.85	0.11	-1.24	0.2160	0.66	1.10
Fruits and Vegetables	1.08	0.16	0.51	0.6120	0.81	1.44
Nuts and Dry fruits	1.01	0.23	0.03	0.9790	0.64	1.59
Quesadillas	0.99	0.15	-0.07	0.9430	0.74	1.32
Age	1.08	0.07	1.08	0.2800	0.94	1.23
Sex	0.95	0.12	-0.40	0.6890	0.74	1.22
Cons	0.13	0.14	-1.87	0.0620	0.01	1.11

Note: BMI: Body Mass Index; IRR: Incidence Rate Ratios; Robust SE: Robust Standard Error. Exposition defined based on daily recommendations (Table SM2.1); *Statistical significance was considered at $p \leq 0.05$; Confidence interval at 95%.

Multivariable Poisson regression analyses for unhealthy snack intake

Table 5 presents the multivariable Poisson regression analysis examining the association between unhealthy snack intake and BMI-for-age z-score categories. After adjustment for age and sex, sweet bread intake was significantly associated with BMI-for-age categories (IRR = 0.67; 95% CI: 0.49–0.91; $p = 0.011$). No statistically significant associations were observed for sweets and chocolates (IRR = 0.98; 95% CI: 0.73–1.30), chips (IRR = 1.21; 95% CI: 0.91–1.62), or sugary drinks (IRR = 0.85; 95% CI: 0.62–1.15) (all $p > 0.05$). The overall model approached but did not reach statistical significance ($p = 0.0636$; pseudo $R^2 = 0.0137$). Age (IRR = 1.06; 95% CI: 0.93–1.20) and sex (IRR = 0.94; 95% CI: 0.73–1.21) were not significantly associated with BMI-for-age categories in the adjusted model.

Table 5. Multivariable Poisson regression analysis of BMI-for-age z-score categories according to unhealthy snack intake

BMI-for-age z score	IRR	Robust SE	z	Pseudo R2 = 0.0137		
				p-value = 0.0636		
				p-value	95% CI	
Sweets and Chocolates	0.98	0.14	-0.16	0.8750	0.73	1.30
Sweet bread	0.67	0.11	-2.55	0.0110*	0.49	0.91
Chips	1.21	0.18	1.30	0.1950	0.91	1.62
Sugary drinks	0.85	0.13	-1.06	0.2870	0.62	1.15
Age	1.06	0.07	0.87	0.3860	0.93	1.20
Sex	0.94	0.12	-0.51	0.6110	0.73	1.21
Cons	0.19	0.20	-1.58	0.1140	0.02	1.50

Note: BMI: Body Mass Index; IRR: Incidence Rate Ratios; Robust SE: Robust Standard Error. Exposition defined based on daily recommendations (Table SM2.1); *Statistical significance was considered at $p \leq 0.05$; Confidence interval at 95%.

DISCUSSION

The relationship between snacking and adolescent obesity remains controversial¹⁰. Previous studies have reported inconsistent findings, suggesting that snack type, frequency, and overall dietary context may influence obesity risk rather than snack consumption per se^{4,5}. In the present study, BMI-for-age z-score showed strong correlations with central adiposity indicators, supporting its validity as the primary obesity outcome. However, snack intake classified according to daily portion recommendations was not consistently associated with excess weight.

Contrary to studies reporting increased obesity risk with frequent consumption of energy-dense snacks⁶, our multivariable Poisson models did not show significant associations between healthy snack intake and BMI-for-age categories. Similarly, most unhealthy snack categories were not significantly associated with excess weight after adjustment for age and sex. These findings align partially with Keast et al.⁴ and Nicklas et al.²⁹, who reported mixed associations between snacking and obesity outcomes, suggesting that isolated snack episodes may not independently determine weight status.

Although regression models were largely non-significant, descriptive analyses revealed significant differences in sweets and chocolates intake between BMI categories. Interestingly, adolescents with adequate BMI reported higher median intake of sweets and chocolates than those with excess weight. This finding may reflect reporting bias, dietary restraint among

adolescents with overweight or obesity, or compensatory behaviors not captured by the questionnaire. It also reinforces the complexity of interpreting snack-obesity relationships in cross-sectional designs 30,31.

Among unhealthy snacks, sweet bread showed a significant association in the Poisson model. However, the direction and magnitude of this association should be interpreted cautiously, as the overall model explained a small proportion of variance and residual confounding cannot be ruled out. These results suggest that individual snack items may behave differently depending on portion size, overall dietary context, and compensatory intake patterns 32.

Importantly, snack consumption during school hours may represent only a fraction of total daily intake. Because total energy and dietary patterns were not assessed, it is possible that adolescents compensate snack intake with other meals throughout the day. Previous research indicates that overall dietary patterns, rather than single food items, better explain obesity risk^{1,29}. Therefore, evaluating isolated snack consumption without considering total dietary intake may underestimate or misrepresent its contribution to excess weight.

Despite the predominance of ultra-processed snack options, both normal-weight and adolescents with excess weight reported fruit and vegetable intake during school snack time. Although intake did not consistently meet WHO recommendations of 400 g/day²⁴, snack time may still represent an opportunity to improve dietary quality. However, portion size remains critical, as even nutritionally favorable foods may contribute to positive energy balance when consumed in excess^{4,27}.

These findings should be interpreted in light of the broader Mexican school food environment, where availability of both healthy and unhealthy snacks coexists⁵. Although national policies have aimed to regulate school food environments and reduce sugar-sweetened beverage consumption³³, implementation gaps may limit their effectiveness.

This study has several limitations. The use of the SBFQ did not allow full assessment of total dietary intake or overall energy consumption. Only school snack intake was evaluated, which may not represent total daily consumption. In addition, the cross-sectional design precludes causal inference. The study did not include key contextual variables such as socioeconomic status or physical activity, both of which are recognized determinants of adolescent obesity and may

influence snack selection and energy balance. Although models were adjusted for age and sex as minimal essential confounders, residual confounding cannot be ruled out. Therefore, findings should be interpreted cautiously and within the context of school snack consumption rather than overall dietary patterns. Nevertheless, the results suggest that when snack intake is operationalized according to daily portion recommendations, its isolated association with excess weight appears limited in this adolescent population.

CONCLUSION

In this study, snack consumption during school hours showed limited association with BMI-for-age z-score categories. Although adolescents with excess weight tended to report higher median intake of unhealthy snacks and lower intake of healthy snacks, most differences were not statistically significant. In comparative analyses, only sweets and chocolates differed significantly between BMI categories. In multivariable Poisson regression models adjusted for age and sex, healthy snack intake was not associated with excess weight. Among unhealthy snacks, only sweet bread showed a statistically significant inverse association with excess weight, while no other snack categories were independently associated with BMI-for-age z-score status. Additionally, global model fit statistics indicated weak explanatory capacity. These findings suggest that snack intake alone, when evaluated independently and without considering total dietary intake, may not be a strong determinant of adolescent excess weight. The relationship between snacking and obesity appears to be multifactorial and likely influenced by broader dietary patterns, total energy intake, and lifestyle factors not assessed in this study. Future research should incorporate complete dietary assessment and longitudinal designs to clarify the role of snack quality and quantity in adolescent weight status. Strengthening school food environments remains important, but interventions should be integrated within comprehensive nutritional strategies rather than focusing solely on snack consumption.

AUTHORS' CONTRIBUTIONS

Conceptualization, M.G.C.B., M.L.M., V.G.A.C., F.E.H., S.H.M., and N.R; data collection, M.G.C.B., N.O., J.A.F.L.; formal analysis, M.G.C.B., M.L.M., N.O., J.A.F.L.; Methodology, M.G.C.B., M.L.M., V.G.A.C., F.E.H., S.H.M., and N.R; investigation, M.G.C.B., M.L.M., V.G.A.C., F.E.H., S.H.M., N.R. N.O., J.A.F.L.; writing—original draft preparation, M.G.C.B., and M.L.M.; writing—review and editing, M.G.C.B., M.L.M., V.G.A.C., F.E.H., S.H.M., N.R., N.O., and J.A.F.L.; visualization, M.G.C.B., M.L.M., V.G.A.C., F.E.H., S.H.M., and N.R; funding acquisition, M.G.C.B., V.G.A.C., and F.E.H. All authors have read and agreed to the published version of the manuscript.

FUNDING

National Council for Science and Technology (CONAHCYT) for the scholarship to the CVU 713505

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY

Data described in the manuscript, code book, and analytic code will be made available upon request pending through the corresponding authors.

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