

Dietary habits and cardiometabolic risk in adolescents in southern Tamaulipas

Hábitos alimentarios y riesgo cardiometabólico en adolescentes del sur de Tamaulipas

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RESUMEN

El riesgo cardiometabólico constituye uno de los principales problemas de salud pública debido a su estrecha asociación con las enfermedades no transmisibles. Entre los factores que lo condicionan se encuentran los patrones de alimentación inadecuados (sobrepeso y obesidad), la inactividad física y las alteraciones en la presión arterial. En este contexto, el objetivo del estudio fue analizar la asociación de estos factores con el riesgo cardiometabólico en adolescentes de una escuela pública del sur de Tamaulipas. Se realizó un estudio transversal, descriptivo y asociativo, mediante la aplicación de un cuestionario y la evaluación antropométrica de 508 estudiantes de secundaria, considerando además el nivel socioeconómico. El riesgo cardiometabólico se calculó con base en el índice cintura/talla y se estimó mediante regresión logística binaria. Los resultados indican que 53.7 % de las que respondieron son mujeres, con una edad promedio de 13 años; el 53.9 % presentó sobrepeso y el 43.5 % riesgo cardiometabólico. El modelo indicó que los hombres presentaron un OR = 0.448 ($p < 0.05$), lo que refleja una menor probabilidad de presentar riesgo en comparación con las mujeres. La presión arterial diastólica también se asoció significativamente con el riesgo (OR = 1.12; $p < 0.05$), de modo que cada incremento de 1 mmHg lo elevó 1.12 veces. El consumo frecuente de alimentos de bajo valor nutricional aumentó el riesgo (OR = 1.36; $p < 0.05$), mientras que la ingesta de pan integral y la práctica de ejercicio se asociaron con menor riesgo. No se identificó efecto de la edad ni del nivel socioeconómico. Estos hallazgos refuerzan la necesidad de implementar estrategias preventivas que promuevan estilos de vida saludables desde etapas tempranas de la vida.

Palabras clave: Adolescentes, alimentación, obesidad infantil, riesgo cardiometabólico.

ABSTRACT

Cardiometabolic risk constitutes one of the main public health problems due to its close association with non-communicable diseases. Among the conditioning factors are inadequate eating patterns (overweight and obesity), physical inactivity, and blood pressure alterations. In this context, the objective of the study was to analyze the association of these factors with cardiometabolic risk in adolescents from

a public school in southern Tamaulipas. A cross-sectional, descriptive, and associative study was conducted using a questionnaire and anthropometric evaluation of 508 secondary school students, also considering socioeconomic level. Cardiometabolic risk was calculated based on the waist-to-height ratio and estimated using binary logistic regression. The results indicate that 53.7 % of respondents were female, with a mean age of 13 years; 53.9 % were overweight, and 43.5 % presented cardiometabolic risk. The model indicated that males had an OR = 0.448 ($p < 0.05$), reflecting a lower likelihood of presenting risk compared to females. Diastolic blood pressure was also significantly associated with risk (OR = 1.12; $p < 0.05$), such that each one mmHg increase raised it 1.12 times. Frequent consumption of low-nutritional-value foods increased risk (OR = 1.36; $p < .05$), whereas whole-grain bread intake and physical activity were associated with lower risk. No effect of age or socioeconomic level was identified. These findings reinforce the need to implement preventive strategies that promote healthy lifestyles from early stages of life.

Keywords: Adolescents, diet, childhood obesity, cardiometabolic risk.

INTRODUCTION

In the last five decades, the prevalence of childhood obesity has increased worldwide, predominating in low- and middle-income countries. In this regard, the World Obesity Federation estimates that by 2030, about 250 million children and adolescents will be obese (Jebeile *et al.*, 2022).

The World Health Organization (2018) points out that adolescence is a phase of life that runs from 10 to 19 years of age, in which organic and psychosocial changes usually define adolescents' behavior or conduct in adulthood. In this stage, abstract, logical, and scientific thinking begins, so it is considered of great value to develop multiple skills, which in turn lead to certain habits or lifestyles. Adolescents between 15 and 17 are at high risk of developing inappropriate behaviors, considered unhealthy habits that affect their quality of life in adulthood (Güemes-Hidalgo *et al.*, 2017; WHO, 2018).

Currently, lifestyles have changed due to industrialization and technological development in societies, mainly characterized by inadequate diets and physical inactivity,

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which has increased the risk of developing non-communicable diseases (NCDs). Mexico has not been the exception since, despite having an extensive gastronomic variety, consumption patterns have been westernized in recent years, replacing the intake of regional food with highly processed products. For example, the National Health and Nutrition Survey (ENSANUT 2022) indicates that the prevalence of the consumption of non-recommended or unhealthy foods in the population under 20 years of age is alarming, with the intake of sweetened beverages being the highest, representing 93.6 % in schoolchildren, 90.3 % in adolescents and 82.6 % in preschoolers. The second most consumed group of foods are snacks, sweets, and desserts, where adolescents occupy a prevalence of 55.4 %, and the third is sweet cereals. If we add to each region or locality's cultural, social, and economic diversity, it is difficult to define a general pattern of behavior. Therefore, it is necessary to identify eating habits and physical activity as part of the lifestyle in specific contexts (Álvarez *et al.*, 2020; Legarreta-Muela *et al.*, 2023).

In recent years, food has been a constant focus of research due to the growing presentation of eating disorders, which have favored the development of overweight and obesity (WHO, 2018). In Mexico, the ENSANUT report (2022) indicates that the prevalence of overweight and obesity in schoolchildren is 37.3 % and 41.1 % in adolescents. This prevalence is indeed worrying since overweight and obesity are pathologies that reduce life expectancy and, at the same time, increase cardiometabolic risk at an early age. It is worth noting that abdominal obesity in childhood is the one with the highest risk for developing cardiometabolic diseases, which represents a health problem for society and highlights the vulnerability of this age group (Jebeile *et al.*, 2022). The presence of cardiometabolic risk in adolescence is associated with the development of NCDs, such as insulin resistance, diabetes mellitus, cardiovascular diseases (hypertension, dyslipidemia, atherosclerosis), and cancer, among others, and their aggravation at later ages (Álvarez *et al.*, 2020). Therefore, it is important to study how eating habits and physical activity affect the probability of presenting cardiometabolic risk to understand a little more about the nature of the problem and generate preventive strategies.

MATERIAL AND METHODS

Study design and data collection procedures

This cross-sectional study, conducted between February and March 2024, employed a quantitative approach that integrated descriptive, associative, and correlational methods. It took place at a public high school in Ciudad Madero, Tamaulipas, Mexico, which offers both morning and evening shifts, with the morning shift chosen through non-probabilistic convenience sampling. Initially, 556 students enrolled in the morning shift were considered; however, 48 students who did not complete the survey were excluded, resulting in a final sample of 508 adolescents. The study received approval from the ethics and research committees of the Faculty of Medicine at the Autonomous University of Tamaulipas, and

all procedures complied with the Declaration of Helsinki. Before implementation, an interview was conducted to clarify the project's scope, and the school director granted formal authorization through an official letter. This approval enabled the development of a work agenda for the information collection visits. Additionally, written informed consent was obtained from parents, and assent was secured from the participating adolescents.

Two trained professionals administered the instrument in each classroom. Meanwhile, a family doctor measured the students' anthropometric data and blood pressure in a private area of the school, accompanied by either a teacher, a parent, or the adolescent's legal representative.

Instrument and variables

An instrument consisting of 3 sections was used. In the first section, sociodemographic data were recorded. In the second section, anthropometric data (weight, height, waist, and hip circumference with which cardiometabolic risk was calculated), as well as systolic blood pressure (SBP) and diastolic blood pressure (DBP) were included. In the third section, the test validated by Martínez *et al.* (2025) was used, called *Healthy Lifestyles in Diet, Physical Activity and Emotional State in Adolescents (AAFEEA)*, which is useful to identify eating habits based on the Plate of Good Eating, as well as the physical activity performed by adolescents according to WHO recommendations (Barquera, 2020; Cuj *et al.*, 2021). In its validation, this instrument demonstrated good internal consistency, with a Cronbach's $\alpha = .777$ reported by Martínez *et al.* (2025).

Blood pressure assessment

A Welch Allyn brand baumanometer was used, with a bracelet or cuff of sizes adult 11, small adult 10, and child 9 (model DS44MC, made in Mexico), in addition to a Littmann Classic III Standard Finish stethoscope (model 5627, made in the USA). The steps recommended by the European Society of Arterial Hypertension were followed to obtain adequate blood pressure figures or values (Padwal *et al.*, 2020; Álvarez *et al.*, 2022).

Procedure

Each adolescent was questioned to make sure that no stimulant substances such as chocolate, soft drinks, or energy drinks have been used, and that they had not smoked or exercised 30 minutes before taking the BP. The teenager was seated in a chair with a straight back, feet flat on the floor, and arm resting on a table at heart level, in a quiet environment with no companions present to avoid disturbing him, and was asked not to speak during the measurements. The arm was selected for the measurement.

Subsequently, the appropriate cuff for each adolescent was selected according to the arm circumference obtained at the midpoint between the shoulder and the elbow. The cuff was placed on the arm 2 - 3 centimeters above the antecubital fossa, being well adjusted, both in the upper and lower part. The stethoscope was placed on the brachial artery, and the

baumanometer was insufflated until the pulse was no longer felt and disappeared. Finally, the reading was carried out to identify Korotkoff's Noises, which help indicate the ED figures in adolescents. The procedure consisted of opening the knob so that the needle of the baumanometer descended at a moderate speed until the systolic blood pressure was identified, and the last sound was identified as the diastolic blood pressure (Padwal *et al.*, 2020).

Anthropometric evaluation

Each teenager was weighed using a Xiaomi electronic floor scale (model NUN4048GL, made in China) with a capacity of 200 kg. The size was obtained using a retractable tape measure, Singer brand (model 50003, made in China), with a capacity of 2.4 meters (96 inches), placed perpendicular to the longitudinal axis of the body and horizontal to the floor, fixing the head in a horizontal plane to obtain the measurement.

Weight and height values were used to establish the body mass index (BMI), the Quetelet index, by dividing the weight in kilograms by the height in meters squared ($BMI = \text{Kg}/\text{m}^2$).

Nutritional status was obtained using data from the national health card as a reference, according to each adolescent's age and sex.

Waist and hip circumference were measured with the Singer retractable measurement tape (model 50003, made in China). The diameter of the waist was obtained by measuring at the level of the middle part, between the lower border of the tenth rib of the thorax and the upper edge of the iliac crest, while the adolescent was standing, after inhalation and exhalation of air. The hip's diameter was measured by placing the tape at the level of the more significant protrusion of the buttocks. Anthropometric parameters were measured without shoes, metal accessories, or hair or head accessories.

Cardiometabolic risk

Cardiometabolic risk was calculated by using the specific cut-off points corresponding to the different anthropometric indices, which allowed the estimation of abdominal fat. These indices are widely used to evaluate and detect central obesity, functioning as predictors of the development of cardiovascular diseases and metabolic diseases.

The Waist/height index (WHtR) was obtained by dividing the waist circumference by the individual's height. Its interpretation was as follows for both sexes: a value greater than or equal to 0.50 indicates an increase in cardiometabolic risk. In contrast, a value below 0.50 is considered healthy and risk-free (Padrón *et al.*, 2016).

The Waist/hip index (WHR) was calculated by dividing the waist circumference by the hip circumference. Its interpretation varies according to sex: in men, a value less than or equal to 0.90 is considered healthy, while a value greater than 0.90 indicates cardiometabolic risk. In women, a value less than or equal to 0.85 is healthy, while a value greater than 0.85 suggests cardiometabolic risk (González *et al.*, 2020).

Socioeconomic level

The socioeconomic level was determined using the instrument known as the 7x8 Rule of the Mexican Association of Market Intelligence and Opinion Agencies (AMAI, 2022). This questionnaire collects information on various aspects of the household, including the number of members who live in it, the assets available (such as bathrooms, bedrooms, cars, and internet), whether any member of the family under 14 years of age works and the educational level of the head of the household.

The socioeconomic classification is established from a regression model used to review the methodology. This system allows Mexican households to be categorized based on factors such as economic and social well-being, space needs, health and hygiene, comfort, and privacy, associating these elements with the quality of life of the household (Araiza *et al.*, 2022; AMAI, 2022; AMAIMO, 2022; Araiza *et al.*, 2023).

Statistical analysis

Descriptive statistics, including frequency, mean, standard deviation, and percentage, were obtained for the variables age, sex, and socioeconomic level. Statistical differences in anthropometric and blood pressure variables between males and females were analyzed using the Mann-Whitney U test, since these variables did not follow a normal distribution. Subsequently, a binary logistic regression was estimated to determine the probability of classifying a student as having cardiometabolic risk, calculated from the waist-to-height ratio (WHtR), based on blood pressure (systolic and diastolic) and the frequency of consumption of foods with low nutritional value. The model was applied using Wald's forward selection method, which removes variables that are not relevant to the final model. An odds ratio (OR) greater than 1 for a predictor variable indicates an increased likelihood of the event occurring, whereas an OR less than 1 indicates a decreased probability. The model's goodness of fit was assessed using Nagelkerke's R-squared, and the Hosmer-Lemeshow test was employed to evaluate calibration. All estimates were performed with SPSS statistical software (IBM, version 25).

RESULTS

Sociodemographic data

Of the total students surveyed, 53.7 % were women, and 46.3 % were men. The average age was 13 ± 0.99 years, the height was 1.58 m, and the weight was 55.5 kg.

Table 1 shows the socioeconomic levels obtained through the AMAI methodology. Levels C-, D+, D, and E are considered low-income levels (31.9 %); level C is considered a middle-income level (27.8 %); and A/B and C+ levels are considered high-income levels (40.4 %). The population sample covered the different socioeconomic levels.

Nutritional status

The nutritional status indicated that women had a higher rate of excess weight (62.2 %), mainly associated with being

Table 1. Distribution of socioeconomic levels, by sex according to AMAI 2022.**Tabla 1.** Distribución de niveles socioeconómicos, por sexo según AMAI 2022.

Socioeconomic level*	Frequency (%)		
	Women	Men	Total
A/B	52 (19.0%)	38 (16.2%)	90 (17.7%)
C+	57 (20.9%)	58 (24.7%)	115 (22.6%)
C	68 (24.9%)	73 (31.1%)	141 (27.8%)
C-	54 (19.8%)	41 (17.4%)	95 (18.7%)
D+	35 (12.8%)	19 (8.1%)	54 (10.6%)
D	6 (2.2%)	6 (2.6%)	12 (2.4%)
E	1 (0.4%)	0	1 (0.2%)
Total	273	235	508

* A/B. This is the level with the highest socioeconomic well-being in Mexico. It is a household headed by someone with a bachelor's or postgraduate degree (82 %). The majority (98 %) have internet access at home, and this level allocates 10% of household spending to education and the lowest proportion to food (28 %).

C+. This level ranks second in socioeconomic well-being, where households usually own at least one car for family transportation, and 93 % have fixed internet access at home. Approximately one-third of household spending is allocated to food (32 %), and 28 % to communication and transportation. C. Eight out of ten households are found in this level. The head of the household has education beyond primary school, and 77 % have fixed internet access at home. Food accounts for 35 % of household spending, while 7 % is allocated to education.

C-. Three out of four households fall within this level. In 74 % of them, the head of the household has education beyond primary school; 52 % have fixed internet access at home. Spending is distributed with 38 % going to food and 24 % to communication and transportation.

D+. Six out of ten households are classified in this level. In 62 % of these, the head of the household has education beyond primary school; 22 % have fixed internet access at home. Food accounts for 42 % of household spending, while 7 % is allocated to education.

D. This is the second-lowest level of socioeconomic well-being in Mexico. In 56 % of these households, the head of the family has only completed primary education. Only 4 % have fixed internet access at home. Household spending allocates 46 % to food and 16 % to communication and transportation.

E. This is the level with the lowest socioeconomic well-being in Mexico. In this level, 95 % of households are headed by someone who has only completed primary education. Internet access is almost nonexistent (0.2 %). Household spending allocates 52 % to food and 11 % to transportation, communication, and housing.

overweight and, to a lesser degree, with obesity. In the case of men, the excess weight rate was 44.3 %, almost comparable for both nutritional stages (Table 2).

Anthropometric Assessment and Blood Pressure

Women had slightly higher values ($P < 0.05$) than men in terms of waist circumference, hip circumference, and waist-to-height index, but men had higher systolic blood pressure (

Cardiometabolic risk

Waist/height index (WHtR) established that 42.66 % ($n = 221$) of the sample ($n = 508$) presented a cardiometabolic risk. Women had a higher frequency (145) than men (76) (Table 4). In the case of women, the rate was higher for those who were overweight (53.1 %) and in men for those who were obese (65.8 %). A higher prevalence of risk was also detected

Table 2. Percentage frequency distribution of nutritional status.**Tabla 2.** Distribución de frecuencias porcentuales del estado nutricional.

Nutritional status	Percentage frequency		
	Women	Men	Total
	(n = 273)	(n = 235)	(n = 508)
Normal	37.7	55.7	46.1
Overweight	44.3	22.6	34.3
Obesity	17.9	21.7	19.7
Excess Weight (Overweight + Obesity)	62.2	44.3	53.9

Table 3. Anthropometric parameters and blood pressure.**Tabla 3.** Parámetros antropométricos y presión arterial.

Variable/ Measure	Mean $\pm$ Standard deviation			U de Mann Whitney (p-value)
	Total	Women	Men	
Waist Circumference	78.68 $\pm$ 11.01	79.68 $\pm$ 10.82	77.5 $\pm$ 11.13	0.008
Hip Circumference	88.87 $\pm$ 10.21	90.15 $\pm$ 9.89	87.39 $\pm$ 10.39	0.003
Waist/Height Index	0.5 $\pm$ 0.07	0.51 $\pm$ 0.06	0.47 $\pm$ 0.06	0.000
Waist/Hip Index	0.88 $\pm$ 0.05	0.88 $\pm$ 0.05	0.89 $\pm$ 0.05	0.957
Systolic blood pressure	101.91 $\pm$ 10.64	101.46 $\pm$ 9.95	102.43 $\pm$ 11.40	0.042
Diastolic blood pressure	63.72 $\pm$ 5.61	63.4 $\pm$ 5.33	64.11 $\pm$ 5.90	0.201

in women with normal weight than in men with the same nutritional status (Table 4).

When using the waist/hip index (WHR), 53.28 % ($n = 276$) of the total participants ($n = 508$) presented a cardio-metabolic risk, with women having a higher frequency (200) than men (76). The prevalence of risk by nutritional status was higher in overweight women and obese men (Table 4).

Eating habits

The eating patterns of adolescents (Table 5) show that males consumed more carbonated and energizing beverages, as well as hamburgers, than females, all considered unhealthy foods (the latter when associated with high-calorie fast food). However, they also, in general, consumed more healthy foods, such as legumes, meat, eggs and rice, boxed bread or whole-grain crackers, and even water. In the case of women, they did not frequently consume energy drinks and reported consuming more starchy foods (potatoes, tubers).

Adolescent boys reported a higher rate of eating breakfast before leaving home and bringing lunch to school prepared at home (Table 6).

Physical activity

It was possible to identify that 21.1 % of the respondents did not exercise or engage in any physical activity; 24.8 % exercised daily, and the rest exercised occasionally (one to three times a month).



Table 4. Frequency distribution by sex and nutritional status of adolescents at cardiometabolic risk.**Tabla 4.** Distribución de frecuencias según sexo y estado nutricional de adolescentes con riesgo cardiometabólico.

State nutritional	Cardiometabolic risk (WHtR)			Cardiometabolic risk (WHR)		
	Women (n = 145)	Men (n = 76)	Total (n = 221)	Women (n = 200)	Men (n = 76)	Total (n = 276)
Normal	13.1 %	2.6 %	9.5 %	28.0 %	36.8 %	30.4 %
Overweight	53.1 %	31.6 %	45.7 %	50.0 %	7.9 %	42.0 %
Obesity	33.8 %	65.8 %	44.8 %	22.0 %	42.1 %	27.6 %

Table 5. Frequency of weekly consumption of the different food groups by sex.**Tabla 5.** Frecuencia de consumo semanal de los diferentes grupos de alimentos según sexo.

Group	Foods	Women	Men
Unprocessed or minimally processed foods	Milk alone	Up to 2 times	Up to 6 times
	Plain water*	Up to 4 times	Up to 6 times
	Fruits***	Up to 2 times	Up to 2 times
	Vegetables***	Up to 2 times	Up to 2 times
	Legumes	Up to 2 times	Up to 6 times
	Meat (chicken, beef, pork or fish)	Up to 2 times	Up to 6 times
	Egg	Up to 2 times	Up to 6 times
	Rice	Up to 2 times	Up to 6 times
	Tubers (potato or sweet potato)	Up to 2 times	Up to 1 time
Processed foods	Cheese	Up to 2 times	Up to 2 times
	Yoghurt	Up to 2 times	Up to 2 times
	Corn tortilla	Up to 6 times	Up to 6 times
	Boxed bread, bolillo or whole grain crackers	Up to 2 times	Up to 6 times
Ultra-processed foods	Carbonated beverages	Up to 6 times	Up to 6 times
	Energy drinks	0	Up to 1 time
	Food with low nutritional intake **	Up to 2 times	Up to 2 times
	Pizza	Up to 1 time	Up to 1 time
	Burgers	Up to 1 time	Up to 2 times
	Hog dog	Up to 1 time	Up to 1 time

*6 or more glasses daily; **Fried, cockpits, sweets, etc.

***2 or more servings.

Table 6. Usual times of food consumption by gender.**Tabla 6.** Horarios habituales de consumo de alimentos según el género.

Food Timing Habits	Women	Men
Eat breakfast before leaving home	Up to 1 time	Up to 2 times
Bring lunch to school prepared from home	Up to 1 time	Up to 2 times
Eating out	Up to 2 times	Up to 2 times
You give the three meals (breakfast, lunch and dinner)	Up to 6 times	Up to 6 times

Women were active up to twice a week, while men were active up to six times.

Binary logistic regression analysis

Table 7 shows the significant variables ($P < 0.05$) that make up the predictive model of logistic regression developed. The sex of the people, with a value of 0.448 for men, indicates that being a man decreases the cardiometabolic risk. At the same time, high diastolic BP increased the possibility of presenting problems by 1.122 times.

The variables associated with the frequency of consumption of high-calorie foods or foods with low nutritional intake, such as hot dogs or fried foods, cookies, and sweets, increased the chances of presenting cardiometabolic problems. On the contrary, the consumption of whole meal bread or crackers and the frequent practice of a sport reduced it. According to Wald's forward selection method, the rest of the variables included in the study were eliminated from the model as they did not present a significant effect.

The fit of the model, calculated with Nagelkerke's R squared, indicated that the proposed variables explained 23.0 % of the dependent variable, an interesting value in the case of a variable of multifactorial origin. Likewise, the test by Hosmer and Lemeshow (0.785) indicated that applying the binary logistic regression model with the data obtained was appropriate.

The model allows for the correct classification of 67.9 % of the cases in a general way. The sensitivity of the model, the probability of adequately classifying cases with cardiometabolic problems, was 52.2 %. In contrast, the specificity, the likelihood of adequately classifying the cases without problems, was 77.7 %. These results suggest that improving the model by introducing other variables with an effect is possible.

DISCUSSION

The present study allowed us to identify the nutritional status, food consumption patterns, and cardiometabolic risk in adolescents living in southern Tamaulipas.

The prevalence of excess weight (overweight and obesity) in 54 % of adolescents, with a higher rate in women, represents a significant risk factor for the health of this population, as it is well above the national average. The 2016 National Health and Nutrition Survey (ENSANUT, 2017) established that the prevalence of overweight in adolescents was 22.4 %, while obesity reached 13.9 %. When analyzing data from the last 28 years (1988-2016), it was observed that in young women, the prevalence of overweight reached 42.2 %, while obesity increased by 290.5 %.

The period analyzed for men was 16 years (2000 to 2016), with a prevalence of overweight of 1.1 % and obesity of 42.8 %. These values have continued to increase, recently reaching a prevalence of overweight of 23.9 % and obesity of 17.2 % in adolescents, according to ENSANUT (2022).

Between 2012 and 2016, the prevalence of obesity in women increased by 5.4 %, while in men, there were no

significant changes, which suggests that women have had a higher prevalence of poor nutrition for decades. On the other hand, Zermeño *et al.* (2020) reported that adolescents ($n = 278$) living in the capital of San Luis Potosí showed an overweight and obesity prevalence of 38.9 %.

The food consumption patterns evaluated by the Martínez *et al.* (2025) test indicate that men tend to register a higher frequency of unhealthy and healthy consumption (Table 5), while women only registered a higher frequency of consumption of tubers (potato or sweet potato). However, the prevalence of excess weight (Table 2) and cardiometabolic risk were higher for this latter population group (Table 4).

The consumption of snacks such as fried foods, cookies, and sweets, with a frequency of up to 2 times a week, suggests that the population still has a predilection for foods considered to have a low nutritional contribution. This behavior coincides with the ENSANUT report (2022), which places snacks, sweets, and desserts within the first three types of foods with the highest consumption, and considered not recommended due to their high carbohydrate content for the population under 20 years of age; with a prevalence of more than 40 % of the population in its consumption (Gaona *et al.*, 2023). In this regard, Monroy *et al.* (2018), in their study of 89 adolescents from León, Guanajuato, Mexico, reported that the most prevalent frequency of consumption was soft drinks, followed by foods with low nutritional intake, such as cookies, sweets, juices, cereals with sugar, and chocolates, among others. Meanwhile, Cerecedo-Lugo *et al.* (2024) reported that 49.4 % of minors in a school sample (8 to 11 years old) located in Reynosa, Tamaulipas, regularly consumed industrialized sugary drinks, mainly juices and flavored waters.

It is important to note that, in this study, men had a higher frequency of food consumption. However, they also reported more physical activity, which could explain why the prevalence of excess weight was lower than that of women.

Nutritional status, measured through BMI, is often widely used, as the World Health Organization establishes it as

Table 7. Variables with significant effect ($P < 0.05$) in the binary logistic model estimation.

Tabla 7. Variables con efecto significativo ($P < 0,05$) en la estimación del modelo logístico binario.

Variable	B	P-value	EXP(B) OR	95% C.I. for EXP(B)	
				Lower	Upper
Gender (Male=1)	-0.804	0.000	0.448	0.296	0.677
Diastolic blood pressure (mmHg)	0.115	0.000	1.122	1.081	1.164
How often do you eat foods with low nutritional intake (fried foods, cookies, sweets, etc.)? (5-point interval scale)	0.309	0.001	1.362	1.127	1.646
How often do you eat hot dogs prepared away from home? (5-point interval scale)	0.285	0.006	1.33	1.086	1.629
How often do you eat boxed bread, bolillo, or whole-grain crackers? (5-point interval scale)	-0.196	0.023	0.822	0.693	0.974
If you do a sport, how often do you practice it? (5-point interval scale)	-0.168	0.018	0.846	0.736	0.972
Constant	-7.946	0.000	0		

a reliable indicator for diagnosing obesity. However, among its limitations is that it only refers to excess body fat and not to its distribution, in addition to the fact that the population under 20 years of age is in its body development, so this indicator may not adequately differentiate muscle mass from bone mass (Padrón *et al.*, 2016). The use of anthropometric indicators in addition to BMI makes it possible to complement the report of nutritional status and thus, identify the risk of people presenting cardiovascular or cardiometabolic problems. According to Luengo *et al.* (2009), these alternative anthropometric indices are the waist/height index (WHtR) and the waist/hip index (WHR). Likewise, authors such as López *et al.* (2019) and Alva *et al.* (2020), highlight that the amount of visceral or intra-abdominal fat (abdominal or central obesity) is a more specific predictive indicator of cardiometabolic risk. In this sense, they point out that, in childhood and adolescence, fat tends to accumulate predominantly in the trunk.

In the present study, the WHR showed a higher prevalence of risk compared to the WHtR, even among adolescents with normal weight (Table 4). Nevertheless, Martín *et al.* (2017) indicate that the index with the most excellent discriminatory power to identify abdominal obesity is the WHtR, as it shows stronger anthropometric correlations; therefore, they recommend its use for the identification of cardiovascular risk. Similarly, the meta-analysis by Ying *et al.* (2008) also identified the WHtR as the best predictor for estimating cardiometabolic risk, in addition to being the most widely used indicator to assess fat distribution and abdominal obesity. For this reason, in the present study the WHtR was employed as the reference index for risk estimation in the binary logistic regression model.

The estimates indicated that women presented a higher cardiometabolic risk in both WHtR and WHR, according to the data reported by Hernández *et al.* (2023), who conducted a study in Cuban adolescents. However, other studies found that men were at higher risk (Matos *et al.*, 2021; Gotelli *et al.*, 2022). Thus, social, cultural, economic, and geographical contexts can affect the types of diseases and their prevalence.

The binary logistic regression model identified the effect of the proposed variables on the probability that a person presents cardiometabolic risk. The variables that explained this risk within the study population were the person's sex, the consumption of whole-grain bread and crackers, and the frequency of physical activity per week. In contrast, high diastolic BP, the frequency of consumption of foods with low nutritional intake and hot dogs, increased the risk (Table 7). For example, the results in Table 7 indicate that men present an OR = 0.448 ($p < .05$, 95 % CI [0.296, 0.677]), which shows that they are less likely to develop cardiometabolic risk compared to women. Likewise, diastolic blood pressure was significantly associated with cardiometabolic risk (OR = 1.12; $p < .05$; 95 % CI [1.081, 1.164]). This means that for every 1 mmHg increase in diastolic blood pressure, cardiometabolic risk is 1.12 times higher, indicating that as diastolic pressure increases, so does the probability of presenting this risk. No effect of age or socioeconomic level was identified.

CONCLUSION

The prevalence of overweight and obesity in the population studied (53.9 %) was higher than the national average, and 43.5 % of the total adolescents surveyed presented cardiometabolic risk, with adolescents being the most vulnerable group. The result obtained suggests that this public health problem continues with an upward trend, which is worrying because its incidence is associated with the development of non-communicable diseases (cardiometabolic), which are initiated in early stages and can worsen in adulthood.

Food consumption patterns and physical activity levels were found to be inadequate, particularly among adolescent girls. This highlights the need to strengthen health education programs that promote healthy eating habits and regular exercise within basic education institutions. It is essential to implement strategies for the periodic evaluation of nutritional health—through anthropometric parameters such as the WHtR—alongside the assessment of dietary habits and physical activity, to monitor trends and design targeted interventions. These interventions should actively involve students, their parents, teachers, and health professionals to foster sustainable habit changes that improve the quality of life during adolescence. Furthermore, identifying nutritional status from childhood is necessary to develop programs from early stages that contribute to long-term health improvements. In this regard, the adoption of the WHO Health Promoting Schools framework, incorporating biannual WHtR screening, represents a practical and comprehensive strategy to advance adolescent health promotion.

CONFLICT OF INTEREST

The authors of this study declare that they have no conflict of interest in preparing this manuscript.

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