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Sedentary Lifestyle, Total Carbohydrate and Added Sugar Intake, and Their Association with Overweight/Obesity in Costa Rican Children and Adolescents

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Abstract

Introduction: Childhood overweight and obesity are complex and multifactorial conditions arising from an imbalance between caloric intake and energy expenditure. **Methods:** A cross-sectional study was conducted involving 2.420 students aged 9 to 17 years from 64 educational centers in Costa Rica. Eating habits were assessed using a validated questionnaire, and Body Mass Index (BMI, kg/m^2) was calculated to determine the prevalence of overweight and obesity, classified according to CDC standards. Ethical approval was granted by the Scientific Ethics Committee of INCIENSA, and informed consent was obtained from all participants. To estimate carbohydrate and added sugar intake, three different methods were applied to approximate consumption levels. Descriptive statistics and stepwise regression models were used with statistical significance set at $p < 0.05$. **Results:** The prevalence of being overweight and obesity among the students was 27.1% and 16.8%, respectively. The likelihood of being overweight or obese was significantly associated with a higher daily intake of total carbohydrates and added sugars. Key sources of total carbohydrates (accounting for 50.1% to 60.7%) and added sugars (accounting for 73.1% to 88.2%) included foods such as bakery products, cookies and cakes, carbonated beverages, cereals, juices and nectars, and flavored milks. Near 83.8% of children and adolescents in our country consumed more than 10% of their total energy intake from added sugars, exceeding the World Health Organization recommendation (<10% of

total energy intake (optimal < 5%). **Conclusion:** In Costa Rica, there is an urgent need to modify dietary habits through educational initiatives and social awareness campaigns.

Keywords

Carbohydrates, Added Sugars, Overweight, Obesity, Costa Rica

1. Introduction

Nutritional education, the promotion of physical activity, and access to healthy foods are fundamental components in the prevention and management of childhood overweight and obesity [1]. Childhood obesity represents not only a significant individual health concern but also reflects structural inequalities, impacting physical, cognitive, and emotional development [1]. The imbalance between energy intake and physical activity is not solely attributable to personal choices but is influenced by a complex interplay of environmental, economic, and cultural factors [2].

In Costa Rica, childhood obesity is a public health problem that negatively affects the physical and cognitive development of children, increasing the risk of non-communicable diseases (NCDs), which represent the principal cause of mortality in the country and are directly related to diet [3]-[5]. According to the 2016 school census of weight/height, nearly 34% of the population between 6 and 12 years of age presented overweight [5]. Recent studies also suggest that school-aged children in Costa Rica are consuming diets rich in sugars and fats, exceeding international public health recommendations for daily intake of these products [6]. This situation represents a challenge, as children with a diet rich in these components are more likely to develop obesity and metabolic diseases [7].

Guevara-Villalobos *et al.* (2019) revealed that schoolchildren in Costa Rica tend to include products with a high content of fats, sugars, and sodium in their diets. These foods, specially processed snacks and sweetened beverages, represent more than 50% of the daily calories consumed by school-aged children [8]. These data are alarming, as they reflect a considerable prevalence of ultra-processed foods in the youngsters' diet, which are associated with the development of metabolic and cardiovascular diseases from early ages [9]. Foods that commonly are part of the diet include cookies, potato chips, carbonated drinks, and artificial juices. These products are rich in saturated fats, added sugars, and sodium, components that have been identified as noxious for infantile health when consumed in excess [10].

Addressing childhood obesity requires robust public policies that foster environments conducive to healthy decision-making for children, adolescents, and their families. These policies should include regulations on the marketing of unhealthy foods and the creation of safe spaces for physical activity, with an emphasis on health promotion [2].

A comprehensive, multi-sectoral approach is essential to combat childhood

obesity effectively. This strategy must encompass nutritional education, the promotion of physical activity, and equitable access to healthy foods. Such measures are critical for preventing and managing childhood and adolescent obesity, thereby reducing the burden of associated chronic diseases [11] [12].

While a natural preference for sweet flavors is inherent to human biology, fostering healthy eating habits and promoting balanced diets are vital [13]. Educational initiatives and the availability of nutritious options play key roles in mitigating the rising consumption of added sugars and their detrimental health impacts.

Excessive sugar intake, particularly from processed foods, has been identified as a significant contributor to the global obesity epidemic and related chronic conditions. Encouraging the consumption of natural, fresh foods over highly processed alternatives is imperative. Reducing the intake of sugary beverages and promoting healthier options, such as water or unsweetened dairy drinks, can substantially enhance health outcomes and prevent diet-related diseases [14].

The World Health Organization (WHO) guidelines emphasize the importance of limiting sugar intake to prevent various health issues [15]. Raising awareness about the risks associated with excessive sugar consumption and promoting healthy dietary habits are crucial steps toward building healthier communities and reducing the prevalence of diet-related diseases from an early age.

Excessive sugar intake also has a significant impact on oral health, as free sugars contribute to the development of cavities and other dental conditions. Limiting added sugar is, therefore, essential for maintaining optimal oral health, in accordance with WHO recommendations [15] [16]. Furthermore, sugary beverages pose a nutritional challenge due to their low content of essential vitamins and minerals, which can contribute to an unbalanced diet. Given their association with childhood obesity, it is important to assess the broader impact of these products, alongside sedentary lifestyles, on the overall health of children and adolescents [17]. In Costa Rica, there is an urgent need to modify dietary habits, particularly among children and adolescents, through educational initiatives and social awareness campaigns. Failure to address these patterns could lead to an increased prevalence of overweight, obesity, and related comorbidities in the future. This study aims to assess the association between sedentary behavior, carbohydrate and added sugar intake, and the prevalence of overweight and obesity among children and adolescents in Costa Rica.

2. Method

This cross-sectional study involved 2420 students aged 9 to 17 years from 24 primary schools and 40 high schools across the seven provinces of Costa Rica. Participants completed a structured, coded questionnaire comprising three sections: (A) sociodemographic information (sex, age, and socioeconomic status) and lifestyle/family habits; (B) anthropometric data; and (C) information on recreational and physical activities.

Weight (kg) and body fat percentage were measured using bioelectrical impedance analysis (Tanita SC-331 S scale, without column). Height was recorded with a SECA 217 stadiometer, and waist circumference (WC) was assessed using a standard measuring tape. Body Mass Index (BMI, kg/m^2) and waist-to-height ratio (WHtR) were subsequently calculated for each participant.

The prevalence of overweight and obesity was determined based on BMI percentiles, following the Centers for Disease Control and Prevention (CDC) reference guidelines. Overweight was classified as a BMI percentile between the 85th and 95th percentiles, while obesity was defined as a BMI at or above the 95th percentile, adjusted for age and sex [18].

Cardiometabolic risk was assessed using a WHtR cut-off point of 0.50 [19], and WC thresholds were applied according to Taylor *et al.* (2000) [20]. All anthropometric measurements were conducted by trained researchers using standardized protocols.

To ascertain sedentary behavior, average daily screen time (0 - 24 hours/day) was rigorously quantified. This metric was derived from the self-reported frequency of engagement in four distinct sedentary behaviors on both weekdays and weekends: watching television, using computer or gaming console, internet access, and telecommunication via telephone or Skype. Consistent with established pediatric guidelines promulgated by the American Academy of Pediatrics [21] and further recommendations by Tremblay *et al.* (2017) [22], a conservative screen time threshold of ≤2 hours per day was adopted as the criterion for distinguishing between sedentary and active individuals.

The assessment instrument also incorporated items pertaining to the frequency of physical activity undertaken outside of the school environment (ranging from "never" to "daily", with an operationalized average of ≥60 minutes/day) [23], as well as inquiries regarding participation in physical activity programs within the school setting.

Participants were classified as "physically active" if they fulfilled two of the following evidence-based criteria: (1) documented average daily screen time not exceeding 2 hours, and (2) self-reported engagement in physical activity outside of school for a minimum duration of 60 minutes per day on at least three days per week. Individuals failing to satisfy both predefined conditions were, by explicit definition, classified as "sedentary". This bifurcated classification scheme ensured a standardized and objective determination of physical activity levels across the study population.

Part C of the questionnaire consisted of a semi-quantitative food frequency survey. Daily added sugar intake was estimated by multiplying the standard serving size of each food by a frequency coefficient: never = 0; 1 - 3 times/month = 0.07; 1 - 2 times/week = 0.21; 3 - 4 times/week = 0.50; 5 - 6 times/week = 0.80; once daily = 1; and 2 - 3 times/day = 2.5 [24] [25]. This frequency list included commonly consumed foods in Costa Rica, with an open section allowing students to add other items [26]. This questionnaire was adapted from one previously used

and validated in a survey by this research team and applied individually with the supervision of two nutritionists [26]. A comprehensive list of 120 foods, encompassing both homemade and processed items representative of the Costa Rican diet and typical global dietary patterns of children and adolescents, was compiled [27] (**Table 1**).

It is important to note that naturally occurring sugars in fruits, vegetables, and milk were excluded from the added sugar calculation, although they were included in the total carbohydrate intake assessment for each participant.

Table 1. Food groups analyzed.

Food Groups	Foods, drinks and preparations
Sweet or salty pastries and sandwiches	Sweet or savory pastries, empanadas*, churros, puff pastry sandwiches, and similar items.
Fast food	Pizza, hot dogs, beef or chicken tacos, fried chicken, tortillas with cheese, chorreada* (traditional Costa Rican dish), hamburgers, mixed nachos, and Chinese dishes (such as Cantonese rice and chop suey), among other fast-food items commonly sold at McDonald's, Burger King, KFC, and similar establishments.
Tomato sauce (ketchup) or pink sauce	Ketchup and pink sauce (a mixture of ketchup and mayonnaise).
Cereals (gallo pinto*, among others)	Whole and refined grains: rice, barley, oats, breakfast cereals, tortillas, gallo pinto* (traditional Costa Rican dish with rice and beans), among others.
Bakery products	Breads, both sweet and savory stuffed breads, baguettes (plain or with cheese), and breadcrumbs.
Sweet and salty cookies and cakes	Any type of cracker (filled or unfilled) and cakes.
Snacks in small packages	Toasted potatoes, fried plantains, and various types of popcorn.
Milk and dairy products	Whole, semi-skimmed, or skimmed milk, yogurt, flavored milk, and sweetened condensed milk.
Legumes	Any variety or color of beans, lentils, chickpeas, peas
Starchy vegetables	Potatoes, cassava, sweet potatoes, tiquisque, ñampi, and other similar root vegetables.
Fruits	Papaya, melon, watermelon, bananas, guava, soursop, oranges, tangerines, and other fruits.
Sweet confectionary, desserts and ice creams	Candies, popsicles, gummies, chocolates, cajetas* (traditional candy), syrups, gelatin, jellies, jams, desserts, and creamy or water-based ice creams.
Non-starchy vegetables	Green beans, carrots, cabbage, tomatoes, zucchini, lettuce, cucumber, and other vegetables.
Sports drinks	Any brand or type of sports drink.
Energy drinks	Any brand or type of energy drink.
Cola or carbonated drinks	Cola and other carbonated drinks (excluding unsweetened versions) and sweetened carbonated waters.
Non-carbonated drinks	Flavored non-carbonated beverages, flavored teas, industrialized drinks flavored with tropical fruits, and isotonic drinks.
Homemade drinks	Homemade fruit beverages made with water or milk.
Prepared hot or cold drinks	Agua dulce* (sweetened sugarcane water), coffee, tea bags, and hot chocolate (prepared with water or milk)
Nectars and juices	Nectars and concentrated juices (powdered or packaged) with added sugar.
Alcoholic beverages	Alcoholic beverages, including beer, white or red wine, sparkling wine, whiskey, vodka, rum, and others.

*Typical Costa Rican dish.

Commonly consumed foods providing complex, or simple (refined) carbohydrates were assessed, and added sugar intake was estimated to identify the primary contributors within the study population. Portion sizes for each recorded food item were estimated for each student using the Photographic Manual of Portions of Common Foods and Preparations in Costa Rica and the Weight Book of Homemade Measurements and Portions of Common Foods and Preparations in Costa Rica [28] [29].

Three methods were employed to estimate the carbohydrate and added sugar content of foods:

- Method 1: Carbohydrate and added sugar content were determined using the Central American Food Composition Table from the Institute of Nutrition of Central America and Panama (INCAP) [30].
- Method 2: Nutritional information was obtained from commercial food labels. Carbohydrate and added sugar content per 100 grams was calculated based on the declared serving size and data from the United States Department of Agriculture (USDA) food composition databases [31] [32].
- Method 3: For prepared foods containing multiple ingredients, carbohydrate and added sugar content was calculated using standardized recipes provided by participants or referenced from the Home Measurements and Portions of Common Foods and Preparations Weight Book of Costa Rica [29].

To evaluate the appropriateness of added sugar consumption, actual intake data were compared with the World Health Organization (WHO) recommendation of limiting free sugars to less than 10% of total energy intake (TEI) [15]. Free sugars include monosaccharides and disaccharides added to foods, as well as sugars naturally present in honey, syrups, and fruit juices.

Various types of sugars were analyzed, including table sugar (white), brown sugar, corn sweetener, corn syrup, dextrose, fructose, glucose, sucrose, high-fructose corn syrup, honey, inverted sugar, maltose, malt syrup, and molasses. Additionally, sugars added to beverages such as coffee, tea, and traditional homemade drinks (prepared with fresh fruit juice, sugar, and water or milk) were considered. In accordance with World Health Organization (WHO) guidelines, the intake of these sugars should be limited to less than 5% of total energy intake (TEI) [15].

2.1. Statistical Analysis

The normality of the data distribution was assessed using the Kolmogorov-Smirnov test. Descriptive statistics—including arithmetic means, standard deviations (SD), medians, and minimum and maximum values—were calculated. Depending on the normality of the variables, parametric and non-parametric tests were applied. For data with more than two categories, analysis of variance (ANOVA) or the Kruskal-Wallis test was used. Correlations were evaluated using Pearson's r or Spearman's r coefficients. Confidence intervals were set at a 95% confidence level, and homogeneity and chi-square tests were applied based on age and sex distributions. Statistical analyses were conducted using the IBM SPSS software package [33].

Logistic regression analysis was performed to determine statistically significant differences between BMI categories and sex in relation to energy intake, total carbohydrates, and added sugars. Additionally, t-tests and stepwise regression analyses were applied, with variable elimination based on the probability of the Wald statistic. A p-value of ≤0.05 was considered indicative of statistical significance.

2.2. General and Ethical Procedures

All procedures adhered to the ethical standards outlined in the 1975 Helsinki Declaration and its subsequent amendments (2013). Written informed consent was obtained from parents or legal guardians, while assent was secured from the participating children and adolescents. The study received ethical approval from the

Scientific Ethics Committee of INCIENSA (Ordinary session #27 of October 19, 2010; IC-2010-05).

3. Results

In the Costa Rican student population, 27.1% were classified as overweight and 16.8% as obese (Table 2). A strong positive correlation was observed between waist circumference (WC) and body mass index (BMI) ($r = 0.745$, $p < 0.001$), accounting for 56% shared variance. Similarly, a moderate positive correlation was identified between waist-to-height ratio (WHtR) and BMI ($r = 0.617$, $p < 0.01$), with 37% shared variance. Notably, 32.5% of participants exhibited cardiometabolic risk (WHtR > 0.50), corresponding to the 71.2nd percentile for girls and the 71.9th percentile for boys.

More than half of the children and adolescents (57.9%) were classified as sedentary, and 68.3% did not meet screen time recommendations. Only 47.8% were categorized as active, adhering to the recommended guidelines. Approximately 59.6% of total energy intake was derived from carbohydrates, with 16.4% coming from added sugars (Table 2).

The likelihood of being overweight or obese was significantly higher among females and those with higher daily energy, total carbohydrate, and added sugar consumption. Conversely, this probability decreased markedly among students classified as active. Based on generalized determination coefficients (Cox and Snell's R^2 and Nagelkerke's R^2), 44.4% to 59.0% of the variance in excess weight was explained by the predictor variables evaluated (Table 3).

Stepwise regression analysis revealed that the primary contributors to total carbohydrate intake (accounting for 50.1% to 60.7% of total energy intake) were also the main sources of added sugars (73.1% to 88.2%). These food groups included bakery products, cookies and cakes, carbonated drinks, cereals and/or gallo pinto (a traditional Costa Rican rice and bean dish), non-carbonated beverages, prepared hot and cold drinks, and particularly juices and nectars (Table 4).

Notably, cookies and cakes, non-carbonated drinks, juices and nectars were frequently consumed as mid-morning and afternoon snacks. On average, 83.8% of children and adolescents exceeded the recommended intake, obtaining more than

10% of their total energy intake from added sugars.

Table 2. Characteristics of the study population.

Characteristics	Mean	Standard deviation	Median	Minimum	Maximum
Age (years)	12.95	2.294	13.00	9	17
Weight (Kg)	48.7218	14.46525	47.0000	24.80	136.50
Height (cm)	153.7773	11.42982	154.0000	125.50	186.00
BMI (Kg/m^2)	20.2775	4.28032	19.4339	14.62	40.44
Waist Circumference (WC)	73.7851	11.43406	72.2000	58.20	168.3
Cardiometabolic Index (WHtR)	0.4796	0.06602	0.4684	0.19	0.86
Body Composition (Fat %)*	22.0682	13.08173	19.8000	3.98	62.00
Total energy intake (TEI) (Kcal/day)	2244.2113	189.88606	2144.4000	1149.09	3409.03
% of energy from total carbohydrates	59.5581	3.09823	59.0843	40.95	74.39
% of energy from simple sugars	16.4322	5.86637	15.9806	6.92	30.66
Sedentary			57.9%		
Does not adhere to the recommended guidelines for screen time usage			68.3%		
Is physically active and adheres to the recommended screen time limits			47.8%		
Nutritional status based on BMI		Normal 56.1%	Overweight 27.1%	Obesity 16.8%	

* = % percentage; Kg = kilograms; cm = centimeters; m^2 = square meter.

Table 3. Logistic regression analysis identifying factors associated with excess weight (overweight and obesity).

Factor	B	Sig.	Exp(B)	95% C.I. for EXP(B)	
				Inferior	Superior
Active (1, sedentary = 0)	−0.350	0.003	0.705	0.560	0.887
TEI (Kcal/day)	0.108	0.000	1.114	1.111	1.118
Female sex (1, masculine = 0)	0.259	0.026	1.295	1.139	1.623
Carbohydrates (grams)	0.117	0.000	1.124	1.119	1.129
Added sugars (grams)	0.329	0.000	1.389	1.352	1.427
Constant	−31.003	0.000	0.000		

Table 4. Step-by-step regression analysis of the contribution of each food group to the total energy, carbohydrate and added sugar intake of the study population.

Energy (Kcal)	**R^2**	**% of contribution**	**Total Carbohydrates**	**R^2**	**% of contribution**	**Added sugar**	**R^2**	**% of contribution**
Alcoholic Beverages	0.002	0.2	Tomato sauce (ketchup) or pink sauce	0.096	9.6	Tomato sauce (ketchup) or pink sauce	0.100	10.0
Sports drinks	0.063	6.3	Non-starchy vegetables	0.300	30.0	Snacks in small packages	0.587	58.7
Energy drinks	0.077	7.7	Fruits	0.321	32.1	Sweet confectionary, desserts and ice creams	0.642	64.2

Continued

Tomato sauce (ketchup) or pink sauce	0.146	14.6	Snacks in small packages	0.329	32.9	Sweet or salty pastries and sandwiches	0.681	68.1
Non-starchy vegetables	0.206	20.6	Starchy vegetables	0.332	33.2	Cereals	0.693	69.3
Fruits	0.222	22.2	Legumes	0.339	33.9	Milk and dairy products	0.700	70.0
Snacks in small packages	0.246	24.6	Sweet confectionary, desserts and ice creams	0.444	44.4	Homemade drinks	0.720	72.0
Starchy vegetables	0.256	25.6	Sweet or salty pastries and sandwiches	0.450	45.0	Bakery products	0.731	73.1
Legumes	0.257	25.7	Fast food	0.456	45.6	Crackers and cakes	0.780	78.0
Sweet confectionary, desserts and ice creams	0.259	23.9	Cereals	0.471	47.1	Cola or carbonated drinks	0.784	78.4
Sweet or salty pastries and sandwiches	0.261	26.1	Milk and dairy products	0.474	47.4	Non-carbonated drinks	0.789	78.9
Fast food	0.268	26.8	Homemade drinks	0.491	49.1	Prepared hot or cold drinks	0.800	80.0
Cereals	0.386	38.6	Bakery products	0.501	50.1	Nectars and juices	0.882	88.2
Milk and dairy products	0.404	40.4	Cookies and cakes	0.522	52.2			
Homemade drinks	0.421	42.1	Cola or carbonated drinks	0.565	56.5			
Bakery products	0.451	45.1	Non-carbonated drinks	0.584	58.4			
Cookies and cakes	0.532	53.2	Prepared hot or cold drinks	0.597	59.7			
Cola or carbonated drinks	0.535	53.5	Nectars and juices	0.607	60.7			
Non-carbonated drinks	0.540	54.0						
Prepared hot or cold drinks	0.544	54.4						
Nectars and juices	0.557	55.7						

4. Discussion and Conclusions

Obesity and being overweight are multifactorial conditions [34]. Our study, conducted with schoolchildren and adolescents from the seven provinces of Costa

Rica, demonstrated that the likelihood of developing overweight or obesity is associated with higher daily consumption of energy, total carbohydrates, and added sugars, as well as a sedentary lifestyle. Reducing these factors is widely recommended for effective weight management [35]. The World Health Organization (WHO) advocates nutritional programs aimed at reducing obesity rates, which have risen due to a gradual shift from traditional local diets and active lifestyles to Western dietary patterns, characterized by higher levels of fat, salt, sugars, and calorie-dense foods [36].

In schoolchildren and adolescents, an increased probability of overweight or obesity has been observed in association with higher daily intake of energy, total carbohydrates, and added sugars, with a higher prevalence in females. This gender predominance is also noted in the United States, where projections suggest that by 2030, excess weight will affect 55.6% of men, 80.0% of women, 47.6% of girls, and 38.9% of boys [37].

The early onset of adiposity rebound in childhood is a key and effective marker of obesity, the prevalence of which is rising. Notably, this phenomenon occurs earlier in girls than in boys [38].

Regarding physical activity, our findings indicate that the probability of excess weight is significantly lower among individuals classified as "active". Interventions focused solely on physical activity are recommended for preventing obesity, as they have been shown to reduce BMI in children aged 6 to 12 years and in adolescents aged 13 to 18 years. In contrast, there is no evidence supporting the effectiveness of interventions that address diet alone, although those combining diet and physical activity have proven effective [39].

Evidence suggests that increasing physical activity alone is insufficient to control adiposity; it is also crucial to reduce sedentary behaviors [40]. Additionally, strategies to prevent and manage overweight and obesity in children and adolescents should prioritize both total caloric intake and the quality of nutrients consumed.

The consumption of sugary beverages has contributed to the development of overweight people in this population [41]. In this study, the primary food groups responsible for the high intake of carbohydrates and added sugars included bakery products, cookies, cakes, carbonated drinks, cereals, non-carbonated beverages, prepared hot or cold drinks, and particularly juices and nectars.

These findings underscore the importance of reducing the consumption of such products and promoting healthier alternatives, such as water, natural juices, and skim milk. Additionally, concern was raised regarding the frequent consumption of cookies and cakes instead of fruits during mid-morning and afternoon snacks among the study participants.

In 2021, the WHO emphasized the need to educate children, teachers, and families about the importance of consuming healthy foods, reducing the intake of sugars and fats, promoting physical activity, and minimizing sedentary behavior [42]. Furthermore, family interactions, such as communication during meals, have

been shown to positively impact eating habits (increased consumption of fruits and vegetables in children) and physical activity levels (particularly in girls), as reported by Lebron *et al.* (2020) [43].

It is essential to implement policies aimed at reducing unnecessary sugar consumption among children and adolescents through measures such as taxes on sweetened products or warning labels on sugary drinks [44]. Establishing healthy habits in the consumption of sugary drinks and foods from childhood is critical to preventing long-term negative effects on both oral health [45] and overall health.

Highly processed and sweetened products, such as fast food and industrial snacks, are poor in essential nutrients (e.g., vitamins, minerals, and antioxidants) and are rich in empty calories derived from refined flours, sodium, and sugars. Marketing strategies targeted at children and adolescents, especially those on television, the internet, in schools, and in supermarkets, significantly influence their preferences and dietary choices.

Therefore, modifying the advertising and media environment to favor healthy options could promote more beneficial dietary decisions, reducing the risk of obesity and improving the overall health of children and adolescents [46].

The formulation of public policies, the implementation of front-of-pack warning labels (FOP-L), and preventive campaigns are essential strategies to transform the obesogenic environments in which children and adolescents develop daily [47] [48]. Reducing the excessive consumption of sugary and ultra-processed foods, such as those typically found in school sodas, is a priority. The increasing dietary proportion of these foods is associated with higher energy density, greater intake of free sugars, and lower fiber consumption, positioning the consumption of ultra-processed foods as a significant determinant of obesity in this population [49].

Several studies highlight the adverse effects of an unbalanced diet and insufficient physical activity, exacerbated by sedentary screen time, on children and adolescents [50]. In contrast, the current findings demonstrate significant improvements in cardiometabolic health through physical activity in individuals with excess weight [51]. There is robust evidence linking screen time with obesity and adiposity, as well as moderate evidence supporting its association with higher caloric intake [50].

Therefore, it is crucial to promote physical activity as part of interventions targeting excess weight, given the significant impact of sugar consumption on this issue. However, the limitations in strength, fitness, and pain that many children and adolescents with excess weight face must also be addressed. Personalized and progressive physical activity interventions should be designed to encourage the development of new skills and confidence, ensuring positive exercise experiences. These adaptations can help break the cycle of negative participation, facilitating long-term obesity management [52].

This study provides a comprehensive assessment of overweight and obesity

prevalence, cardiometabolic risk factors, dietary patterns, and physical activity levels among Costa Rican students. The findings demonstrate a significant proportion of the student population classified as overweight (27.1%) and obese (16.8%), highlighting the urgent need for interventions to address childhood obesity in this region. These results suggest a potentially escalating trend in overweight and obesity among Costa Rican students, underscoring the importance of proactive public health strategies.

The strong positive correlation observed between waist circumference (WC) and BMI, along with the moderate correlation between waist-to-height ratio (WHtR) and BMI, reinforces the utility of these anthropometric measures in assessing adiposity and associated health risks. The finding that a significant percentage (32.5%) of participants exhibited cardiometabolic risk based on WHtR (>0.50) is particularly alarming, as elevated WHtR has been shown to be a strong predictor of cardiovascular disease and type 2 diabetes [53]. This highlights the need for early interventions targeting abdominal obesity to mitigate long-term health consequences.

The high prevalence of sedentary behavior (57.9%) and excessive screen time (68.3%) observed in this study aligns with global trends reported by the World Health Organization (WHO) which indicates that over 80% of adolescents worldwide are insufficiently physically active [54], emphasizing the pervasive influence of modern lifestyles on children's activity levels. Furthermore, the finding that most participants did not meet screen time recommendations underscores the need for strategies to promote physical activity and reduce sedentary behaviors in this population. A recent intervention study showed that reducing screen time by 1 hour per day led to significant improvements in BMI in children [55].

Dietary analysis revealed that carbohydrates constitute a substantial portion of total energy intake (59.6%), with a concerning 16.4% derived from added sugars. This high intake of added sugars is consistent with previous research demonstrating the detrimental effects of excessive sugar consumption on metabolic health [56]. Stepwise, regression analysis identified key dietary contributors to total carbohydrate and added sugar intake, including bakery products, cookies and cakes, carbonated and non-carbonated beverages, and juices/nectars. The frequent consumption of these items as snacks further exacerbates the problem. The fact that 83.8% of children and adolescents exceeded the recommended intake of added sugars (>10% of total energy intake) confirms the urgent need for public health interventions to reduce sugar consumption and promote healthier dietary choices. This is particularly important given recent evidence linking high sugar intake to non-alcoholic fatty liver disease in children [57].

The identification of specific food groups contributing to high sugar intake provides valuable targets for intervention strategies. For example, educational campaigns and policy initiatives aimed at reducing the consumption of sugary beverages and processed snacks could have a significant impact on reducing added sugar intake and improving overall dietary quality. Furthermore, the finding that

excess weight was associated with female gender, higher daily energy intake, and greater consumption of carbohydrates and added sugars, but inversely associated with physical activity, underscores the complex interplay of factors contributing to childhood obesity.

A limitation of the present study is that only the intake of total carbohydrates, sugars, and total energy was analyzed, without considering the contribution of other energy nutrients, such as proteins and fats. While the current investigation focused primarily on the association between dietary habits, sedentary behavior, and obesity prevalence, data regarding potential confounding factors, such as family history of obesity, parental sedentary lifestyle, and access to healthy foods, were not comprehensively ascertained. Consequently, these variables were not directly incorporated into the statistical modeling framework.

It is acknowledged that the absence of these covariates may introduce a degree of unmeasured confounding, and the interpretation of independent effects of the primary variables of interest should be approached with appropriate caution. Future research endeavors should incorporate a more extensive assessment of these potentially influential factors to facilitate a more complete understanding of the multifaceted etiology of childhood obesity. However, the present findings still provide valuable insights into the relationship between modifiable lifestyle factors and obesity risk within the study population.

Reducing sugar consumption, in conjunction with promoting physical activity, is critical in addressing the high prevalence of obesity in children and adolescents. Structured programs are necessary to engage parents, schools, and communities in this effort [58] [59]. Additionally, further studies are essential to confirm these findings and explore their implications for public health policies in greater detail.

Research on the relationship between sugary drinks, sedentary behavior, and childhood obesity must be conducted using a broader and more rigorous approach to fully understand their effects on the health of this population. High-quality studies and comprehensive reviews are needed to provide solid evidence that can inform both public policy and individual decisions related to sugar consumption, sugary beverages, and sedentary behavior in childhood and adolescence [60] [61].

In conclusion, this study provides valuable data on the prevalence of overweight and obesity, cardiometabolic risk factors, and dietary and activity patterns among Costa Rican students. The findings highlight the urgent need for public health interventions targeting modifiable risk factors such as physical inactivity and excessive sugar consumption. These interventions should focus on promoting healthier dietary choices, increasing physical activity levels, and reducing sedentary behaviors, particularly among vulnerable populations such as females. Further research is warranted to evaluate the effectiveness of different intervention strategies in addressing the growing problem of childhood obesity in Costa Rica and similar settings. Future studies should consider longitudinal designs to assess the long-term impact of these risk factors on cardiometabolic health.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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