World Nutrition 2021;12(4):32-50

Overweight and Obesity among Schoolchildren of Rural Guatemala and the Food Environment around Schools

Ana Gonzalez-Alvarez[1], Sara K. Rosenkranz[1], Tandalayo Kidd[1], María F. Kroker-Lobos[2], Richard R. Rosenkranz[1]

1. Department of Food, Nutrition, Dietetics and Health; Physical Activity and Nutrition Clinical Research Consortium; College of Health and Human Sciences; Kansas State University
2. INCAP Research Center for the Prevention of Chronic Diseases, Institute of Nutrition of Central America and Panama, Guatemala, Guatemala.

Correspondence: Richard R. Rosenkranz, PhD; ricardo@ksu.edu

ABSTRACT

Introduction: Childhood obesity is a principal concern worldwide. Guatemalan households have the highest prevalence of double burden of malnutrition in the world. These households are self-identified as indigenous and live with lower incomes in rural communities. However, there are limited data on risk factors for childhood obesity and limited information regarding the school environments, especially in rural communities. The objectives of this study were to determine the prevalence of overweight and obesity in a sample of rural schoolchildren, evaluate whether there is significant variability across schools, and characterize the food environment around public elementary schools in rural communities.

Methods: A cross-sectional study was conducted in four rural public schools within three villages of El Progreso, a Department (state) of Guatemala, located about 60 km east of Guatemala City. Anthropometric measures and sociodemographic information for 398 schoolchildren and their mothers were collected in 2018. Environmental audits of food outlets and food advertisements were completed for a 250- and 500-meter radius around schools. Food outlets and food advertisements were categorized as healthy and less healthy, or acceptable or not acceptable, respectively, using international protocols. One-way ANOVA was used to compare schools and continuous demographic variables. Fisher's LSD post hoc test was used to examine differences between schools. Chi-Squared tests were conducted to evaluate differences between categorical demographic variables, overweight and obesity, and variables regarding food environments. A logistic regression was used to examine factors associated with overweight and obesity and variability across schools, adjusted for household income, child sex and age, and maternal education and age.

Results: The overall percentage of overweight and obesity among schoolchildren across all four schools was 32.4%. There was a higher percentage of less healthful food outlets compared to healthful food outlets and overall food outlets within <250 meters around the four schools, as compared to food outlets within 500 meters. Logistic regression showed that overweight and obesity status varied significantly (p=0.042) depending of the school students attended, when adjusting for household income, child sex and age, maternal education, and age.

Conclusion: We found a high prevalence of overweight and obesity among schoolchildren in rural communities in Guatemala. There was significant variability in overweight and obesity across schools. Results portray the food environment around schools as a possible contributing factor to childhood obesity.

Key words: overweight, obesity, children, school, food environment, Guatemala

INTRODUCTION

Childhood obesity is one of the major public health nutrition problems of this century. In 2016, more than 41 million children under five years of age were overweight (World Health Organization 2020). According to the Pan American Health Organization (PAHO), in Latin America and the Caribbean (LAC) region, there are approximately four million children less than five years of age who are categorized as overweight (FAO et al., 2019). Children who are overweight or obese are more prone to develop noncommunicable diseases like type 2 diabetes mellitus, hypertension, cancer, and cardiovascular diseases at younger ages (World Health Organization 2020).

Some driving factors of increased levels of overweight and obesity among the world's children are the changes in transportation systems, food demand and supply, foreign investments, and urbanization (Popkin & Reardon 2018). Since 1980, the eating patterns of people in Latin America and the Caribbean regions have changed (Popkin & Reardon 2018). Specifically, there has been an increase in ultra-processed food consumption, accompanied by a decrease in physical activity. All the environments that interact within a community can help create conditions to moderate or reduce the effects of the obesity epidemic (Swinburn et al., 2011). The food environment can be defined as all the physical, economic, and political conditions that determine dietary patterns and some diet-related health outcomes (Pérez-Ferrer et al., 2019).

The International Network for Food and Obesity/non-communicable diseases Research, Monitoring and Action Support (INFORMAS) has defined healthy food environments as places where foods and beverages that shape the population's diet are accessible, available, and fulfill the dietary guidelines (Swinburn et al., 2013). The food environment determines the food options that people can access (Jilcott et al., 2011). An obesogenic food environment encourages the consumption of high-energy and low-nutrient foods and beverages (Williams et al., 2015). During recent years, dietary changes have been seen in national, local, school, and household environments (Corvalán et al., 2017). Schools are considered potentially favorable environments for promoting healthy eating habits and creating healthy food environments by teaching and practicing healthy eating and long-life skills for active living (Story et al., 2009).

Like most Latin American countries, Guatemala has seen accelerated increases in the cases of overweight and obesity (Ramirez-Zea et al., 2014). According to the last National Maternal and Child Health Survey (ENSMI), the national prevalence of overweight and obesity in children younger than five years was 4.9% (Mazariegos, Kroker-Lobos, & Ramírez-Zea 2020). The Guatemalan 2015 World Health Survey for Schoolchildren evaluated the nutritional status of students from seventh to ninth grades and reported a national prevalence of overweight of 29.4% and 8.4% for obesity (Ministry of Health 2015).

To date, the school food environment has barely been studied in Guatemala (Pérez-Ferrer et al., 2019). Studies conducted in Guatemalan elementary schools showed that schools had limited availability of fruits and vegetables and a higher number of energy-dense snacks and sugar-sweetened beverages (Pehlke et al., 2016; Godin et al., 2017). Research has shown that greater availability of ultra-processed foods is related to higher consumption of those types of foods (Pehlke et al., 2016; Chacon et al., 2015). Another study conducted in Guatemala had the objective to evaluate the influence of food marketing on schoolchildren and found that children prefer foods with a cartoon character on the front of the package (Chacon, Letona, & Barnoya 2013). These studies are examples of how the food environment surrounding children influences food consumption among children. Research on the obesogenic food environment has so far received little attention in developing countries (Barrera et al., 2016). Moreover, not much is known about the influences of the food environment that surrounds schools. Many unhealthy foods are available outside the school area and within a short walking distance from the school gate (Barrera et al., 2016). Children's food marketing has also been an issue of concern around schools (Barquera et al., 2018).

Guatemala has a population of 14.9 million inhabitants. Approximately 46% of people live in rural communities, and 41.7% are self-identified as indigenous Mayans (National Institute of Statistics (INE) 2019). More than 75% of indigenous people live in poverty, and around 80% live in rural areas (Ramirez-Zea et al., 2014; Glei & Goldman, 2000). Previous research indicates that Guatemalan households have the highest prevalence of the double burden of malnutrition in the world (Ramirez-Zea et al., 2014). The prevalence of stunted child–overweight mother (SCOM) pairs was 16–18% (Ramirez-Zea et al., 2014). Guatemalan households with higher percentages of SCOM pairs are often self-identified as indigenous and frequently are in lower socioeconomic status (Ramirez-Zea et al., 2014). Despite that, urban settings have been more studied and show an association between weight status and increased consumption of energy-dense and poor nutrient foods and sedentary lifestyles (Torun et al., 2002). However, there has been little documentation on people of rural communities in Guatemala, especially for children. There is no information available on the food environment around schools in rural areas and to what degree the obesity epidemic has reached Guatemalan schoolchildren. Therefore, the purpose of the study was to determine the prevalence of overweight and obesity, whether there is significant variability across schools (when adjusting for other demographic variables), and to characterize the food environment that surrounds public elementary schools in rural communities.

METHODS

Study Design

This cross-sectional study was approved by the Institutional Review Board (IRB) of the Institute of Central America and Panama in December of 2017 and (post hoc) from the IRB of Kansas State University in November 2020.It was conducted in three villages in the Department of El Progreso, about 60 km east of Guatemala City. The inhabitants are of Ladino (Spanish-Amerindian) and indigenous heritage, and live in rural settings (Maluccio et al., 2005). Two of the villages were located in the Municipality (county) of Sanarate, San Miguel Conacaste and San Juan las Flores; and the third one, Santo Domingo Los Ocotes, is part of the Municipality (county) of San Antonio La Paz. The three villages have similar characteristics. For example, they are located in less fertile areas where the soil is shallow and more prone to erosion, hindering agricultural potential. They are 4–8 km away from their municipal capitals, which may indicate poor access to municipal-level health and educational services (Maluccio et al., 2005). Data were collected from February to May 2018.

These villages have been part of the INCAP Oriente Longitudinal Study since its origins in 1969 and have experienced demographic, social, nutritional, and economic changes (Maluccio et al., 2005; Ramirez-Zea, Melgar, & Rivera 2010). Those changes include improvements in access to roads and transportation, increases in non-agricultural employment opportunities, and improved access to education (Maluccio et al., 2005; Ramirez-Zea, Melgar, & Rivera 2010).

Sample Selection

Four schools in three villages were selected for this study, schools that represent 100% of rural primary schools in these villages. San Miguel Conacaste (school 1) and San Juan las Flores (school 2) have one elementary public school that operates in two shifts, one in the morning and one in the afternoon. Santo Domingo Los Ocotes has two elementary public schools with only a morning shift (schools 3 and 4). The average enrollment of each school was approximately 200 students.

A letter to each school's principal was sent to schedule a meeting for authorization to work inside the school, explain the objectives of the study, and ask for collaboration from the schools. After each principal's permission was obtained, the rosters of students were requested from the teachers. Using Microsoft Excel® (version 2106), a random selection was determined to recruit boys and girls from first to sixth grades in each school and shift. Approximately 11 children from each class were necessary for reaching approximately 400 students in total. Anticipating a response rate of 50%, double the number of students per class were invited to participate. Parents of the selected students were invited to attend an informative meeting at the school. Parents who authorized their children to participate completed the informed consent, and the research team asked for verbal assent from each child. A total of eight children with incomplete sociodemographic or anthropometric data were excluded from the study analysis. The final sample size was 398 children between 6 to 15 years of age.

Measures at individual level

Sociodemographic information

The children's mothers or guardians answered a questionnaire about the sociodemographic profile of the family that INCAP previously validated. The questionnaire contained information about the children's age, mother's/guardian's age and educational level (<6th grade or ≥6th grade), and monthly household income (<US$400 (equivalent to the minimum wage in Guatemala) or ≥US$400) (Ministry of Labor and Social Security 2021). A total of 11 mothers replied that the household income was per day, and one did not respond. Mothers may have experienced discomfort answering the household income question or may have had part-time jobs or work in the informal economy; these mothers' household incomes were classified as <US$400 monthly income.

Anthropometric measures

Anthropometrics were measured using standardized and validated methods (World Health Organization 2008). Bodyweight was measured using digital scales (Tanita, Model HD-51), and the height was measured using portable stadiometers with 1-mm precision (Seca, Model 213). Each measure was taken in duplicate, and the results were later averaged.

Body mass index (BMI) (kg/m2) and BMI-for-age z scores were calculated using the WHO Anthro Plus software. BMI-for-age Z-scores more extreme than ±5SD were considered plausible and included in analysis. Overweight was defined as a Z-score between ≥1SD and <2SD, and obesity was defined as a Z-score ≥2SD above the mean for BMI-for-age (World Health

Organization 2021). Underweight was defined as a Z-score of ≤-2SD of the mean, while severe underweight was defined as a Z-score of ≤-3SD of the mean for BMI for age. Normal weight was defined as a Z-score between -2SD and 1SD for BMI for age. Stunting was defined as a Z-score of ≤-2SD of the mean for height-for-age according to the WHO growth charts (World Heath Organization 2021).

Measurements of the food environment at community level

Definition of buffer areas around schools

In order to map food outlets and food advertising around schools, we used standardized methods to define circular buffers around schools (Mackay, Molloy, & Vandervijvere 2017). Maps were generated using the application of Google Earth®. We choose the main door of each school as the center of the circular buffer and defined two independent circular buffer zones as a radius of <250 meters and <500 meters around schools using the QGIS® software version 2.14 (QGIS, 2021; Mackay, Molloy, & Vandervijvere 2017).

Advertisements around schools

The visual advertisements were defined as all the posters, banners, signs, paintings on walls, boxes, or bottles used as food and beverage marketing tools outside stores, in the streets, houses, bus stops outside schools, within the designated buffer areas. All the information of visual advertisements of ultra-processed, processed foods and beverages (except alcohol) within 500 meters of the schools were recorded using an electronic data capturing system (REDCap™, Vanderbilt University) (Mackay, Molloy, & Vandervijvere 2017).

Using the REDCap™ 7.5.2 online software, research assistants captured the characteristics of each food advertisement, like brand name, size, type, location, and the X and Y coordinates. Researchers geo-referenced each advertisement found within 500 meters around the school. Then, to count how many times each advertisement was repeated in the same place, the advertisement was multiplied by the number of times it was repeated (Mackay, Molloy, & Vandervijvere 2017). Advertisements were classified using the WHO-European system nutrient profile model. This model determines whether a food product may or may not be appropriate for marketing to children (World Health Organization 2010). Finally, researchers evaluated whether the advertisements were permissible, in line with the WHO-European system nutrient profile model criteria.

Food outlets around schools

Food outlets were defined as all corner stores, mobile food vendors, convenience stores, and food establishments (including fast-food restaurants, ice cream shops, temporary street food stands, diners, bakeries, poultry and meat markets, supermarkets, and fruit and vegetable stores) (Ni Mhurchu et al., 2013; Moore & Diez Roux 2006). Even though the mobile food vendors and temporary street food stands are similar, the difference is that mobile food vendors sell their products outside the school gates and only can be found at the beginning and at the end of the school day hours (Barrera et al., 2016).

All the food outlets that were found within 500 meters around schools were recorded using the REDCap™ 7.5.2 online software. However, we made an exception for one quadrant of the diameter around School 4 that was deemed unsafe for assessment. The coordinates X and Y of each food outlet were recorded and geolocated in the villages using the QGIS® application. Then each food outlet was classified according to the type of food sold. The healthy food category included fruits and vegetables stores, poultry and meat market, mobile street vendors that sold fruits or vegetables, and diners (homemade food). In contrast, all the corner stores, fast food chains, mobile street vendors that did not sell fruits and vegetables, convenience stores, ice cream shops, bakeries, and supermarkets were classified as unhealthy food outlets (Ni Mhurchu et al., 2013; Kelly, Flood, & Yeatman 2011).

Statistical Analysis

Descriptive statistics with frequencies were calculated for children's age, nutritional status, mothers' age and education level, and household income were enumerated and compared by schools. Frequencies were run for the number of food outlets, the distance in which food outlets were located, and whether classified as healthful or less healthful, compared by school. Last, frequencies were generated to describe the number of food and beverages advertisements, the distance where they were located, whether they should be permitted for marketing or not, according to the WHO-European nutrient profile, and these were compared by school.

One-way ANOVA was used to assess differences across schools. Where there were statistically significant differences, post hoc Fisher's Least Significant Difference tests were conducted to determine which schools differed from one another. Chi-squared ($\chi2$) tests were conducted to assess differences in categorical variables. The categorical variables were children's sex, mother's age and educational level, and household income. The children's BMI variable was recoded to a dichotomous variable; children with obesity were assigned to a category of overweight/obese (=1) or non-overweight/obese (=0). For food outlets and food advertisements, two categorical variables were created. For food outlets, these included the distance of the food outlets from schools and classification of healthful or less healthful. For food advertisements, the variables were the distance from the school evaluated and whether they met the WHO-European nutrient profile model criteria.

A logistic regression analysis was used to determine the association between overweight and obesity and schools. The categorical variable overweight and obesity was the outcome variable, and the exposure variable was the school in the logistic regression analysis. The model was adjusted according to the child's sex, mother's age and level of education, and household income. IBM SPSS Statistics 27 was used for all statistical analyses, and alpha was set at 0.05.

RESULTS

In total, 398 children (51% boys, 49% girls), participated in the study among those enrolled at four separate schools. The mean age of children was ten years (10.1 years in boys and 9.9 years in girls). After comparing the nutritional status of children in all categories of BMI/age by schools, no significant difference was found (p=0.051). However, when comparing the categorical variable for overweight and obesity by schools, the results showed a significant difference (p=0.039) in the overweight and obesity status. The total prevalence of overweight and obesity was 32.4%. The mean age of the mothers was 34.8 years, which was significantly different by school (p<0.001). The results showed that 68.1% of the mothers had a lower educational level (<6th grade) while 31.9% had 6th grade or higher educational level. Also, 64.3% of the household income was lower than the monthly minimum wage stablished by

Guatemalan goverment (<$400). In addition, 65.9% of children with overweight and obesity resided in households with a monthly income lower than the minimum wage.

Table 1. General characteristics of the sample population in four schools, El Progreso, Guatemala, 2018

	Overall (*n*=398)	**School 1 (San Miguel Conacaste) (*n*=144)**	**School 2 (San Juan las Flores) (*n*=62)**	**School 3 (Santo Domingo los Ocotes 1) (*n*=147)**	**School 4 (Santo Domingo los Ocotes 2) (*n*=45)**	***p*-value (interaction by school)**
Children's Sex						0.656
Female, n (%)	195 (49.0)	68 (47.2)	34 (54.8)	69 (46.9)	24 (53.3)	
Male, n (%)	203 (51.0)	76 (52.8)	28 (45.2)	78 (53.1)	21 (46.7)	
Children's age, years, mean (SD)	10.0 (2.7)	9.7 (2.0)	9.8 (1.8)	10.3 (3.6)	10.2 (2.3)	0.201
Nutritional Status						0.051
Severe thinness [a], n (%)	2 (0.5)	2 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	
Thinness [b], n (%)	13 (3.3)	4 (2.8)	2 (3.2)	3 (2.0)	4 (8.9)	
Normal weight [c], n (%)	254 (63.8)	88 (61.1)	49 (79.0)	89 (60.5)	28 (62.2)	
Overweight [d], n (%)	74 (18.6)	28 (19.4)	6 (9.7)	32 (21.8)	8 (17.8)	0.039*
Obesity [e], n (%)	55 (13.8)	22 (15.3)	5 (8.1)	23 (15.7)	5 (11.1)	
Mother's age, years, mean (SD)	34.8 (7.4)	34.3 (6.6)	32.3 (5.7)	35.3 (7.9)	38.4 (8.7)	<0.001*
Mother's education level						0.075
Education <6 years n (%)	271 (68.1)	87 (60.4)	45 (72.6)	104 (70.8)	35 (77.8)	
Education ≥6 years n (%)	127 (31.9)	57 (39.6)	17 (27.4)	43 (29.2)	10 (22.2)	
Family income [f]						0.177
Family income <$400 n (%)	256 (64.3)	95 (66.0)	46 (74.2)	90 (61.2)	25 (55.6)	
Family income ≥$400 n (%)	142 (35.7)	49 (34.0)	16 (25.8)	57 (38.8)	20 (44.4)	

Nutritional Status was defined according to the WHO Growth references for children 5–19 years. [a] Severe thinness was defined as BMI/age <-3SD; [b] Thinness was defined as BMI/age ≥-3SD to <-2SD; [c] Normal weigh was defined as BMI/age ≥-1SD to <+1SD; [d] Overweight was defined as ≥+1SD to <2+SD; [e] Obesity = ≥+2SD (World Heath Organization 2021).
[f] Family income defined as the equivalent to minimum wage per month according to the Ministry of Labor (Ministry of Labor and Social Security 2021).
*p-value <0.05 is significantly different across schools for the one-way ANOVA or χ^2 test.

Table 2 shows the number of food outlets within <250 meters and <500 meters from the schools, categorized by healthful and less healthful. Overall, a higher number of food outlets were found less than 250 meters around the four schools (73%) compared to food outlets within 500 meters around the schools (p<0.001). Also, when comparing the total number of food outlets by healthfulness category and distance, there were significantly more of the less healthful food outlets (70%) within <250 meters around schools (p=0.021) as compared to within 500 meters. Nearly all of the less healthful food outlets (92%) were found within 250 meters of schools. Besides School 4 (which was not evaluated completely and had some buffer area that overlapped with school 3), School 2 had the lowest prevalence of food outlets (20.5%) in a buffer area of <500 meters compared to the other schools. Among the food outlets, a higher number of corner stores were found in all schools and within <250 meters. Refer to Table 5 in the Annex.

Table 3 describes the food advertisements <250 meters and <500 meters around the schools. According to the WHO-European nutrient profile model criteria, an estimated 94% of these food ads were classified as "not permitted" for marketing.

Table 2. Characterization of food outlets by healthiness, schools, and distance

	Overall* (n=185)		School 1 (n=63)		School 2 (n=38)		School 3 (n=64)		School 4 (n=20)	
	<250m [c]	<500m [d]	<250m	<500m	<250m	<500m	<250m	<500m	<250m	<500m
Less Healthful [a], n (%)	112(83)	48(96)	46(87)	9(90)	18(82)	16(100)	29(73)	23(96)	19(95)	0(0)
Healthful [b], n (%)	23(17)	2(4)	7(13)	1(10)	4(18)	0(0)	11(27)	1(4)	1(5)	0(0)
Total, n (%)	135(100)	50(100)	53(100)	10(100)	22(100)	16(100)	40(100)	24(100)	20(100)	0(0)

The food outlets were classified as less healthy and healthy. [a] Less healthy food outlets were defined as all the corner stores, fast food chains, convenience stores, ice cream shops, bakeries, and supermarkets. [b] Healthy food outlets were defined as fruits and vegetables stores, poultry and meat market, mobile street vendors that sold fruits or vegetables, and diners (homemade food) (Ni Mhurchu et al., 2013; Kelly, Flood, & Yeatman 2011).
[c] Circular buffer zone as a radius of <250 meters around schools. [d] Circular buffer zone as a radius of <500 meters around schools (Mackay, Molloy, & Vandervijvere 2017). Note that buffers listed here are independent of one another so <250m is mutually exclusive of <500m.
*p-value <0.05 is significantly different for the $\chi 2$ test when comparing distance of food outlets by schools.

However, schools were not different when comparing the permitted and not permitted food advertisements for marketing (p=0.268). Results also showed a significant difference (p<0.001) when comparing the distance of the food advertisements by school. The majority of food ads were found nearer the schools (<250m). School 2 had a higher prevalence of food advertisements (32.7%) compared to the rest of the schools. A higher number of sweet beverages advertisements were located within <250 meters around the four schools compared to further away. See Table 6 in the Annex.

Table 4 shows the logistic regression between the outcome variable overweight and obesity and the four schools (exposure). A significant statistical association (p=0.042) was found between the schools and overweight and obesity in schoolchildren, while adjusting for sex, children's age, mother's age, mother's education, and household income. This model suggests that the odds of having overweight and obesity were significantly lower among children in school 2, compared to school 1 (OR=0.392, 95%CI; 0.186, 0.829). The results showed signficant variability in overweight and obesity prevalence across schools.

DISCUSSION

The purposes of this study were to determine the prevalence of overweight and obesity in a sample of rural Guatemalan schoolchildren, evaluate whether there was significant variability across schools, and to characterize the food environment around public elementary schools in rural communities. Nearly one-third of children were overweight or obese, but there was also evidence of under-nutrition. Results showed the prevalence of overweight and obesity varied by school, even when adjusting for household income, child sex, maternal education, and age. Each school had a unique pattern of exposure to food advertisements and food outlets in the vicinity that may be a contributing factor to the observed variability in child weight status.

Table 3. Characterization of food advertisements by WHO advertisement criteria, schools, and distance

	Overall* (n=266)		School 1 (n=54)		School 2 (n=87)		School 3 (n=62)		School 4 (n=63)	
	<250m [c]	<500m [d]	<250m	<500m	<250m	<500m	<250m	<500m	<250m	<500m
Does not meet criteria [a], n (%)	182(95)	68(92)	38(93)	11(85)	42(93)	38(90)	43(98)	18(100)	59(95)	1(100)
Meets criteria [b], n (%)	10 5)	6(8)	3(7)	2(15)	3(7)	4(10)	1(2)	0(0)	3(5)	0(0)
Total	192(100)	74(100)	41(100)	13(100)	45(100)	42(100)	44(100)	18(100)	62(100)	1(100)

The food advertisements were classified as permitted or not permitted according to the WHO-European nutrient profile model criteria for food marketing. [a] Does not meet permission criteria: confectionery, energy bars, cakes and sweets, juices, energy drinks and edible ices. [b] Meets permission criteria: fresh and frozen meat, poultry, fish, fruit, vegetables and legumes. For the other categories, specific thresholds were used for each food group per 100 g. Breads: 2·5 g total fat (TF), 0 g AS, 0 g NSS. Other beverages: 0 g AS, 0 g NSS. Breakfast cereals: 10 g TF, 15 g total sugars (TS) and 1·6 g salt. Yoghurts, sour milk and others: 2·5 g TF, 2·0 g SF, 10 g TS, 0·2 g salt. Cheese: 20 g TF and 1·3 g salt. Ready-made and convenience foods: 10 g TF, 4 g SF, 10 g TS, 1 g salt and 941·4 kJ. Butter and oils: 20 g SF and 1·3 g salt. Bread, bread products and crisp breads: 10 g TF, 10 g TS and 1·2 g salt. Fresh or dried pasta, rice and grain: 10 g TF, 10 g TS and 1·2 g salt. Processed meat, poultry and fish: 20 g TF and 1·7 g salt. Processed fruit, vegetables and legumes: 5 g TF, 10 g TS, 0 g AS and 1 g salt. Sauces, dips and dressings: 10 g TF, 0 g AS and 1 g salt (World Health Organization 2010).
[c] Circular buffer zone as a radius of <250 meters around schools. [d] Circular buffer zone as a radius of 500 meters around schools (Mackay, Molloy, & Vandervijvere 2017). Note that buffers listed here are independent of one another so <250m is mutually exclusive of <500m.
*p-value <0.05 is significantly different for the $\chi 2$ test when comparing distance of food advertisements by schools

Table 4. Association between schools, demographic variables, overweight and obesity

		95% CI for Odds Ratio		
Covariate	**Odds Ratio**	**Lower bound**	**Upper bound**	**p-value**
Schools				0.042*
School 1	(Ref) [a]	(Ref)	(Ref)	(Ref)
School 2	0.392	0.186	0.829	0.014*
School 3	1.137	0.699	1.850	0.605
School 4	0.812	0.385	1.716	0.812
Children's sex				
Boys	(Ref) [a]	(Ref)	(Ref)	(Ref)
Girls	0.679	0.442	1.043	0.077
Household income				
Family income <$400	(Ref) [a]	(Ref)	(Ref)	(Ref)
Family income ≥$400	0.881	0.560	1.386	0.583

*p-value <0.05 is significant difference
[a] (Ref) refers to the reference category in the categorical variables
Association additionally adjusted for children's age, mother's age and educational level.

Currently, no studies specifically pertaining to the obesity epidemic and food environment in rural communities of Guatemala are available within the scientific literature. The Guatemalan 2015 World Health Survey for Schoolchildren reported a national prevalence among adolescents of 29.4% for overweight, and 8.4% for obesity (Ministry of Health 2015). The overall prevalence of overweight and obesity found in the four schools studied here was 32.4%, so the results of this study are in line with what was reported in the 2015 Survey. However, less than one percent of the 2015 Survey sample were children younger than 11 years (Ministry of Health 2015), whereas approximately two-thirds of the current sample were in the 6–10y age range. The current results are similar to another study conducted in a rural community in the Department of Izabal located in the northeast of Guatemala City. Those results showed a prevalence of 23.8% for overweight and 1.1% for obesity in schoolchildren aged 5 to 18 years (Muros et al., 2016). Moreover, these results are similar to one study conducted in an urban area in Quetzaltenango city, located in the west of the country. This study showed that 32.1% of schoolchildren in a high socioeconomic status (SES) had overweight and obesity (Groeneveld, Solomons, & Doak 2007).

A study that analyzed the results of the Guatemala 2014–2015 National Maternal and Child Health Survey (ENSMI) found that overweight and obesity were more prevalent in high-income and non-indigenous children younger than five years old as compared with lower income and indigenous children under five years old (Mazariegos, Kroker-Lobos, & Ramírez-Zea 2020). However, in the current study, there was no association between household income and overweight/obesity, and the school with greatest proportion of low-income families was lowest in prevalence of overweight/obesity. The results of this study were opposite of what has been previously reported (Mazariegos, Kroker-Lobos, & Ramírez-Zea 2020; Groeneveld, Solomons, & Doak 2007). The majority of the schoolchildren with overweight and obesity were found in households with less than the minimum wage monthly income. According to Mazariegos et.al., it has been documented that Guatemala —like many Latin American countries—is in the first stage of the nutrition transition (Mazariegos, Kroker-Lobos, & Ramírez-Zea 2020), where increasing obesity prevalence emerges among women of reproductive age, and among people with higher socioeconomical status as compared to those with lower socioeconomic status (Jaacks et al., 2019). Unfortunately, Guatemala is likely transitioning to later stages because the prevalence of obesity is currently near 10% (Jaacks et al., 2019). According to data in the current study, the prevalence of overweight and obesity in children in rural communities could be higher than 30%. It is possible that another indicator of Guatemala transitioning to other phases is that the gap in socioeconomic levels starting to close or even reverse, potentially explaining why a higher overweight and obesity prevalence was found in the lower-income households (Jaacks et al., 2019; Mazariegos, Kroker-Lobos, & Ramírez-Zea 2020). The use of better socioeconomic indicators to evaluate the association between SES with overweight and obesity is still needed (Barrera et al., 2016).

School 2 was significantly different from school 1, with lower odds of overweight and obesity in school 2. Differences in the food environment around the schools could be affecting the nutritional status of children. A lower presence of less-healthful food outlets was found around school 2, compared with school 1. In addition, when compared to school 1, fewer less-healthful food outlets were located <250 meters around school 2. Furthermore, the healthful food outlets around school 2 were within <250 meters compared to school 1 where healthful food outlets were within 250 and 500 meters. This collectively portrays a food environment that could be protective against overweight and obesity for school 2, relative to other schools, particularly school 1.

A sizeable portion of the food outlets near all schools were corner stores (45%). The majority sold processed and ultra-processed foods, although some sold fruits and vegetables. These types of stores are common and play an influential role in the distribution of ultra-processed foods (Pérez-Ferrer et al., 2020). They are smaller than convenience stores and usually family-owned (Pérez-Ferrer et al., 2020). When the percentage of corner stores between schools was compared, results showed that school 2 had a higher number of corner stores than the rest of the schools. Despite that school 2 had the higher number of corner stores, most of them were located outside of the 250-meter buffer around the school. Opposite to what was found around school 1. Borradaile and colleagues mentioned that closer proximity to corner stores may contribute to frequent snacking behavior, especially children's snacking on unhealthy foods (Borradaile et al., 2009). More fruit and vegetable stores were located <250 meters around school 1 compared with school 2.

However, in the current study no individual evaluation of eating habits or purchase behavior was conducted. More research is needed to evaluate whether or not these findings are responsible for the lower prevalence of overweight and obesity in school 2 compared to school 1. Studies conducted in Latin America and some industrialized countries have reported similar results to what was found around school 1. Many corner stores have been located near the school grounds (Barrera et al., 2016). A study conducted in two Mexican cities found a higher quantity of food outlets around public schools, but did not detect any statistically significant difference associated with children's BMI (Barrera et al., 2016). Other studies in the United States have found associations between adolescent obesity and schools where corner stores are located closer to schools (Rummo et al., 2020; Cobb et al., 2015; Lee 2012). Those studies have found that in low-income areas, obesity is more related to fast-food restaurants and convenience stores (Lee 2012; Rummo et al., 2020; Cobb et al., 2015).

Walton and colleagues have previously discussed that a considerable presence of food marketing around schools is a contributing aspect to childhood obesity (Walton, Pearce, & Day 2009). In the current study, more than 90% of the food that was advertised failed to meet the WHO-European nutrient profile model criteria to be advertised to children. Results also showed a higher prevalence of advertisements that should not be publicized <250 meters around the schools, and the majority of the food advertisements were from sugar-sweetened beverages. This finding is consistent with a previous study conducted in Guatemala that showed that 37% of the food advertisements within 200 meters around public schools were of sugar-sweetened beverages including 30% that were soft drinks (Chacon et al., 2015). A study conducted in Mexico used the Pan American Health Organization—PAHO—recommendations for food and beverage marketing and found that 83.5% of the food advertisements did not fulfill the guidelines (Barquera et al., 2018); these results are concordant with the current study. Another study conducted in El Salvador found similar results: The most predominant advertisements found in rural communities were from sweet sugar beverages followed by snacks (Amanzadeh, Sokal-Gutierrez, & Barker 2015). Mixed results have been published in the literature, however, and additional research is needed.

In the present study, unlike the food outlets, a higher prevalence of food advertisements was found around school 2, resulting from a higher prevalence of corner stores found around school 2. In fact, all food advertisements found around school 2 were in the corner stores (data not shown). However, the prevalence of food advertisements found within <250 meters and <500 meters around school 2 was similar. The number of food advertisements found around school 1 was lower compared to school 2. However, school 1 had a higher prevalence of overweight and obesity. This higher prevalence may indicate that food advertisements around the schools may have less effect on the nutritional status of the children as compared with the presence of food outlets, but future studies would be needed to address that issue.

Strengths and Limitations

The present study has some strengths and limitations that need to be highlighted. One strength is the use of direct measurements like anthropometric measures and the use of standardized and validated methods to describe the food environment, including the exact location of food sales outlets, and food adverstisements. Although these measurements are costly and time-consuming to obtain, they provide a more accurate description of the children's BMI and the food environment respectively. The buffer size can be compared to those used in other studies, but there is no consensus on which is the best buffer size to measure the food environment. Another strength of the current study is the description of the food environment around the schools as a possible contributing factor to the obesity epidemic.

The cross-sectional design of the study is a limitation because it can reflect only associations, not causation. The measures of the food environment and weight status were taken only at one point in time. There is no information on possible changes over time. Since this is the first study that describes the food environment and weight status of schoolchildren in rural communities in Guatemala, it is however a good starting point. Due to the low number of schools and small geographic area covered in the study, the external validity cannot be assured. More research on this topic is needed to comprehend the contributing factors to childhood overweight and obesity at a national level. In addition, information related to eating habits and physical activity in children was not assessed in this study. Furthermore, the general characteristics of the food environment were described, but there was no information on the individual-level of exposure (beyond that offered by the school variable) to the food outlets and the food advertisements.

CONCLUSIONS

The current study identified a high prevalence of overweight and obesity among schoolchildren in rural areas in Guatemala. A high prevalence of less healthful food outlets and food advertisements was observed near the schools, along with low prevalence of healthful food outlets and food advertisements. Significant variability in children's overweight and obesity prevalence was found across schools (with the largest discrepancy between schools 1 and 2). A possible explanation of variability in that prevalence is the food environment that surrounds schools. Although this study only described the food environment around schools as a likely contributor to the overweight and obesity epidemic, further investigation is needed to establish the mechanisms that affect and promote overweight and obesity in schoolchildren in rural communities in Guatemala in order to identify potentially effective solutions.

Acknowledgements

To the INCAP Research Center for the Prevention of Chronic Diseases, for allowing to use their database for a secondary data analysis.

REFERENCES

A Glei D, Goldman N. 2000. "Understanding Ethnic Variation in Pregnancy-related Care in Rural Guatemala." *Ethnicity & Health* 5 (1):5–22. https://doi.org/10.1080/13557850050007301
Amanzadeh B, Sokal-Gutierrez K, Barker; JC. 2015. "An interpretive study of food, snack and beverage advertisements in rural and urban El Salvador." *BMC Public Health* 15(1):521–521. https://doi.org/10.1186/s12889-015-1836-9
Barquera S, Hernández-Barrera L, Rothenberg SJ, and Cifuentes E. 2018. "The obesogenic environment around elementary schools: food and beverage marketing to children in two Mexican cities." *BMC Public Health* 18(1):461–461. https://doi.org/10.1186/s12889-018-5374-0
Barrera LH, Rothenberg SJ, Barquera S, Cifuentes E. 2016. "The Toxic Food Environment Around Elementary Schools and Childhood Obesity in Mexican Cities." *Am J Prev Med* 51(2):264–270. https://doi.org/10.1016/j.amepre.2016.02.021
Borradaile KE, Sherman S, Vander Veur SS, McCoy T, et al. 2009. "Snacking in Children: The Role of Urban Corner Stores." *Pediatrics (Evanston)* 124(5):1293–1298. https://doi.org/10.1542/peds.2009-0964
Chacon V, Letona P, Barnoya J. 2013. "Child-oriented marketing techniques in snack food packages in Guatemala." *BMC Public Health* 13(1):967–967. https://doi.org/10.1186/1471-2458-13-967
Chacon V, Letona P, Villamor E, Barnoya J. 2015. "Snack food advertising in stores around public schools in Guatemala." *Critical Public Health* 25(3):291–298. https://doi.org/10.1080/09581596.2014.953035
Cobb LK, Appel LJ, Franco M, et al. 2015. "The relationship of the local food environment with obesity: A systematic review of methods, study quality, and results." *Obesity (Silver Spring, Md.)* 23(7):1331-1344. https://doi.org/10.1002/oby.21118
Corvalán C, Garmendia ML, Jones-Smith J, et al. 2017. "Nutrition status of children in Latin America: Nutrition status of the Latin American Region." *Obesity Reviews* 18:7–18. https://doi.org/10.1111/obr.12571
Elbel B, Tamura K, McDermott ZT, et al. 2020. "Childhood Obesity and the Food Environment: A Population-Based Sample of Public School Children in New York City." *Obesity (Silver Spring, Md.)* 28(1):65–72. https://doi.org/10.1002/oby.22663
FAO, PAHO, WFP, and UNICEF. 2019. *Regional Overview of Food Security in Latin America and the Caribbean.* (Santiago, Chile: PAHO FAO, WFP and UNICEF). http://www.fao.org/3/ca6979en/CA6979EN.pdf
Godin K, Chacón V, Barnoya J, Leatherdale SC. 2017. "The school environment and sugar-sweetened beverage consumption among Guatemalan adolescents." *Public Health Nutrition* 20(16):2980–2987. https://doi.org/doi:10.1017/S1368980017001926.
Groeneveld IF, Solomons NW, Doak CM. 2007. "Nutritional status of urban schoolchildren of high and low socioeconomic status in Quetzaltenango, Guatemala." *Revista Panamericana de Salud Pública* 22(3):169–177. https://doi.org/10.1590/S1020-49892007000800003
Holsten JE. 2009. "Obesity and the community food environment: a systematic review." *Public Health Nutrition* 12(3):397–405. https://doi.org/10.1017/S1368980008002267
Jaacks LM, Vandevijvere S, Pan A, et al. 2019. "The obesity transition: stages of the global epidemic." *Lancet Diabetes Endocrinol* 7(3):231–240. https://doi.org/10.1016/s2213-8587(19)30026-9
Jilcott SB, Wade S, McGuirt JT, et al. 2011. "The association between the food environment and weight status among eastern North Carolina youth." *Public Health Nutrition* 14(9):1610–1617. https://doi.org/10.1017/S1368980011000668
Kelly B, Flood VM, Yeatman H. 2011. "Measuring local food environments: An overview of available methods and measures." *Health & Place* 17(6):1284–1293. https://doi.org/https://doi.org/10.1016/j.healthplace.2011.08.014

Lee H. 2012. "The role of local food availability in explaining obesity risk among young school-aged children." *Soc Sci Med* 74(8):1193–203. https://doi.org/10.1016/j.socscimed.2011.12.036
Mackay S, Molloy J, Vandervijvere S. 2017. "INFORMAS protocol: Outdoor advertising (school zones)" *The University of Auckland. Journal Contribution*. https://doi.org/https://doi.org/10.17608/k6.auckland.5701102.v2
Maluccio JA, Melgar P, Méndez H, et al. 2005. "Social and economic development and change in four Guatemalan villages: Demographics, schooling, occupation, and assets." *Food and Nutrition Bulletin* 26(2 Suppl 1):S25-45. https://doi.org/10.1177/15648265050262S104
Mazariegos M, Kroker-Lobos MF, Ramírez-Zea M. 2020. "Socio-economic and ethnic disparities of malnutrition in all its forms in Guatemala." *Public Health Nutrition* 23(S1):s68–s76. https://doi.org/10.1017/S1368980019002738
Ministry of Health. 2015. *World Health Survey for Schoolchildren 2015 [Encuesta Mundial de Salud a Escolares 2015].* (Guatemala). http://epidemiologia.mspas.gob.gt/files/Publicaciones%202018/Enfermedades%20No%20Transmisibles/Encuesta%20Mundial%20de%20Salud%20a%20Escolares%20Completo.pdf
Ministry of Labor and Social Security. 2021. "Minimum Wage 2021 (Salario Mínimo 2021)." https://www.mintrabajo.gob.gt/index.php/leyes-y-convenios/30
Moore LV, and Diez Roux LV. 2006. "Associations of neighborhood characteristics with the location and type of food stores." *American Journal of Public Health* 96(2):325–331. https://doi.org/10.2105/ajph.2004.058040
Muros JJ, Briones M, Rodríguez G, et al. 2016. "Double burden of malnutrition in rural and urban guatemalan schoolchildren." *Nutrición hospitalaria: organo oficial de la Sociedad Española de Nutrición Parenteral y Enteral* 33(2):345–350. https://doi.org/10.20960/nh.115
National Institute of Statistics (INE). 2019. *XII National Population and VII Housing Census, Census Results 2018. (XII Censo Nacional de Población y VII de Vivienda, Resultados Censo 2018).* https://www.censopoblacion.gt/documentacion
Ni Mhurchu C, Vandevijvere S, Waterlander W, et al. 2013. "Monitoring the availability of healthy and unhealthy foods and non-alcoholic beverages in community and consumer retail food environments globally." *Obesity Reviews* 14(S1):108–119. https://doi.org/https://doi.org/10.1111/obr.12080. https://doi.org/10.1111/obr.12080
Pehlke EL, Letona P, Hurley K, Gittelsohn J. 2016. "Guatemalan school food environment: impact on schoolchildren's risk of both undernutrition and overweight/obesity." *Health Promotion International* 31(3):542–550. https://doi.org/10.1093/heapro/dav011
Popkin BM, Reardon T. 2018. "Obesity and the food system transformation in Latin America." *Obesity Reviews* 19(8):1028–1064. https://doi.org/10.1111/obr.12694
Pérez-Ferrer C, Auchincloss AH, Barrientos-Gutierrez T, et al. 2020. "Longitudinal changes in the retail food environment in Mexico and their association with diabetes." *Health & Place* 66:102461. https://doi.org/10.1016/j.healthplace.2020.102461
Pérez-Ferrer C, Auchincloss AH, de Menezes MC, et al. 2019. "The food environment in Latin America: a systematic review with a focus on environments relevant to obesity and related chronic diseases." *Public Health Nutr* 22(18):3447–3464. https://doi.org/10.1017/s1368980019002891
QGIS. "QGIS. A free and open source geographic information system." https://qgis.org/en/site/.
Ramirez-Zea M, Kroker-Lobos MF, Close-Fernandez M, Kanter R. 2014. "The double burden of malnutrition in indigenous and nonindigenous Guatemalan populations." *Am J Clin Nutr* 100(6):1644s–1651s. https://doi.org/10.3945/ajcn.114.083857
Ramirez-Zea M, Melgar P, Rivera JA. 2010. "INCAP Oriente longitudinal study: 40 years of history and legacy." *The Journal of Nutrition* 140(2):397–401. https://doi.org/10.3945/jn.109.114470
Rummo PE, Wu E, McDermott ZT, et al. 2020. "Relationship between retail food outlets near public schools and adolescent obesity in New York City." *Health & Place* 65:102408. https://doi.org/10.1016/j.healthplace.2020.102408

Soltero EG, Ortiz Hernández L, Jauregui E, et al. 2017. "Characterization of the School Neighborhood Food Environment in Three Mexican Cities." *Ecol Food Nutr* 56(2):139–151. https://doi.org/10.1080/03670244.2016.1274261

Story M, Nanney MS, Schwartz MB. 2009. "Schools and Obesity Prevention: Creating School Environments and Policies to Promote Healthy Eating and Physical Activity." *The Milbank Quarterly* 87(1):71–100. https://doi.org/10.1111/j.1468-0009.2009.00548.x.

Swinburn B, Sacks G, Hall KD, et al. 2011. "Obesity 1: The global obesity pandemic: shaped by global drivers and local environments." *The Lancet (British edition)* 378(9793):804. https://doi.org/10.1016/S0140-6736(11)60813-1

Swinburn B, Sacks G, Vandevijvere S, et al. 2013. "INFORMAS (International Network for Food and Obesity/non-communicable diseases Research, Monitoring and Action Support): overview and key principles." *Obesity Reviews* 14(S1):1–12. https://doi.org/10.1111/obr.12087

Torun B, Stein AD, Schroeder D, et al. 2002. "Rural-to-urban migration and cardiovascular disease risk factors in young Guatemalan adults." *International Journal of Epidemiology* 31(1):218–226. https://doi.org/https://doi.org/10.1093/ije/31.1.218

Walton M, Pearce J, Day P. 2009. "Examining the interaction between food outlets and outdoor food advertisements with primary school food environments." *Health & Place* 15(3):841–848. https://doi.org/10.1016/j.healthplace.2009.02.003

Wang Y, Jia P, Cheng X, Xue H. 2019. "Improvement in food environments may help prevent childhood obesity: Evidence from a 9-year cohort study." *Pediatric Obesity* 14(10):e12536-n/a. https://doi.org/10.1111/ijpo.12536

Williams J, Scarborough P, Townsend N, et al. 2015. "Associations between Food Outlets around Schools and BMI among Primary Students in England: A Cross-Classified Multi-Level Analysis." *PloS one* 10(7):e0132930-e0132930. https://doi.org/10.1371/journal.pone.0132930

World Health Organization. 2008. Measuring a Child's Growth. In *Training course on Child Growth Assessment*.

World Health Organization. 2010. "Nutrient Profiling." https://www.who.int/nutrition/topics/profiling/en/

World Health Organization. 2020. "Noncommunicable diseases: Childhood overweight and obesity." https://www.who.int/news-room/q-a-detail/noncommunicable-diseases-childhood-overweight-and-obesity

World Health Organization. 2021. "Obesity and Overweight." https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

World Heath Organization. 2021. "Malnutrition in Children." https://www.who.int/data/nutrition/nlis/info/malnutrition-in-children.

ANNEX

Table 5 Characterization of food outlets by school, distance, and type

	School 1		School 2		School 3		School 4		Total	Total
Distance [a]	**<250m**	**<500m**	**<250m**	**<500m**	**<250m**	**<500m**	**<250m**	**<500m**	**<250m**	**<500m**
					Healthy [b]					
Mobile Street vendor, n (%)	1	0	1	0	8	0	0	0	10 (100)	0 (0)
Fruit and vegetable store, n (%)	3	0	1	0	1	1	1	0	6 (86)	1 (14)
Poultry or meat market, n (%)	1	0	0	0	1	0	0	0	2 (100)	0 (0)
Diner (Homemade food), n (%)	2	1	1	0	1	0	0	0	4 (80)	1 (20)
Other, n (%)	0	0	1	0	0	0	0	0	1 (100)	0 (0)
Total, n (%)	7	1	4	0	11	1	1	0	**23 (92)**	**2 (8)**
					Less healthy [c]					
Corner Stores*, n (%)	24	6	14	11	9	10	9	0	56 (68)	27 (32)
Mobile Street vendor, n (%)	1	0	0	0	0	0	0	0	1 (100)	0 (0)
Convenience Store, n (%)	0	0	0	0	0	0	0	0	0 (0)	0 (0)
Bakery/ Tortilla shop, n (%)	8	0	2	0	7	4	5	0	22 (85)	4 (15)
Ice Cream Shop, n (%)	8	1	0	0	2	6	1	0	11 (61)	7 (39)
Super Market, n (%)	0	0	0	0	0	0	0	0	0 (0)	0 (0)
Fast Food Chain, n (%)	0	0	0	0	1	0	0	0	1 (100)	0 (0)
Temporary Food Stand, n (%)	0	1	0	0	6	0	0	0	6 (86)	1 (14)
Other, n (%)	5	1	2	5	4	3	4	0	16 (64)	9 (36)
Total, n (%)	46	9	18	16	29	23	19	0	**112 (70)**	**48 (30)**

[a] Circular buffer zone as a radius of <250 meters and 500 meters around schools (Mackay, Molloy, and Vandervijvere 2017).
The food outlets were classified as less healthy and healthy. [b] Healthy food outlets were defined as fruits and vegetables stores, poultry and meat market, mobile street vendors that sold fruits or vegetables, and diners (homemade food). [c] Less healthy food outlets were defined as all the corner stores, fast food chains, convenience stores, ice cream shops, bakeries, and supermarkets, and mobile street vendor that did not sell fruits and vegetables. (Ni Mhurchu et al. 2013; Kelly, Flood, and Yeatman 2011).

Table 6 Characterization of food advertisements by WHO nutrient profile model and food category, schools, and distance[c]

Classification	School 1				School 2				School 3				School 4			
	<250m		500		<250m		500		<250m		500		<250m		500	
	meets criteria[a]	does not meet criteria[b]	meets criteria	does not meet criteria	meets criteria	does not meet criteria	meets criteria	does not meet criteria	meets criteria	does not meet criteria	meets criteria	does not meet criteria	meets criteria	does not meet criteria	meets criteria	does not meet criteria
Confectionery, n		1								3		4		3		
Cakes, sweet biscuits and pastries, n		2								3				2		
Savory snacks, n		1								2		1		3		
Sweet Beverages, n		25		9		41		33		26		5		38		1
Edible ices, n		5		1		1				5		4		9		
Breakfast cereals, n		1								2		1		1		
Yoghurts, sour milk, cream and other similar foods, n		3		1			1	1		1		1	1	3		
Cheese, n																
Ready-made and convenience foods, n										1		2				
Butter and other fats and oils, n																
Bread, bread products and crisp breads, n																
Fresh or dried pasta, rice and grains, n	3		2		3		3		1				2			
Fresh and frozen meat, poultry, fish and similar, n																
Processed meat, poultry, fish and similar, n								4								

Fresh and frozen fruit, vegetables and legumes, n																
Processed fruit, vegetables and legumes, n																
Sauces, dips and dressings, n																
Total, n	3	38	2	11	3	42	4	38	1	43	0	18	3	59	0	1

The food advertisements were classified as permitted or not permitted according to the WHO-European nutrient profile model criteria for food marketing. [a] Does not meet permission criteria: confectionery, energy bars, cakes and sweets, juices, energy drinks and edible ices. [b] Meets permission criteria: fresh and frozen meat, poultry, fish, fruit, vegetables and legumes. For the other categories, specific thresholds were used for each food group per 100 g. Breads: 2·5 g total fat (TF), 0 g AS, 0 g NSS. Other beverages: 0 g AS, 0 g NSS. Breakfast cereals: 10 g TF, 15 g total sugars (TS) and 1·6 g salt. Yoghurts, sour milk and others: 2·5 g TF, 2·0 g SF, 10 g TS, 0·2 g salt. Cheese: 20 g TF and 1·3 g salt. Ready-made and convenience foods: 10 g TF, 4 g SF, 10 g TS, 1 g salt and 941·4 kJ. Butter and oils: 20 g SF and 1·3 g salt. Bread, bread products and crisp breads: 10 g TF, 10 g TS and 1·2 g salt. Fresh or dried pasta, rice and grain: 10 g TF, 10 g TS and 1·2 g salt. Processed meat, poultry and fish: 20 g TF and 1·7 g salt. Processed fruit, vegetables and legumes: 5 g TF, 10 g TS, 0 g AS and 1 g salt. Sauces, dips and dressings: 10 g TF, 0 g AS and 1 g salt (World Health Organization 2010). [c] Circular buffer zone as a radius of <250 meters and 500 meters around schools (Mackay, Molloy, and Vandervijvere 2017).