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Trabajo Original

Epidemiología y dietética

Overweight and obesity in the Mexican school-age population from 2015 to 2019

Sobrepeso y obesidad en la población mexicana en edad escolar entre 2015 y 2019

Marti Yareli del Monte Vega[1], Abelardo Ávila Curiel[2], Marco Antonio Ávila Arcos[2], Carlos Galindo Gómez[2], Teresa Shamah Levy[3]

[1]Department of Applied Nutrition and Nutrition Education and [2]Division of Nutrition. Instituto Nacional de Ciencias Médicas y Nutrición "Salvador Zubirán" (INCMNSZ). Mexico City, Mexico. [3]Centre for Evaluation and Surveys Reseach (CIEE). Instituto Nacional de Salud Pública (INSP). Cuernavaca, Morelos. Mexico

Abstract

Introduction: between 2006 and 2020, obesity in Mexico increased across all age groups and displayed a homogenizing evolutionary trend throughout, prevalence overweigth and obesity (Ow+Ob) has 38.2% in school age children.

Objectives: to analyze the changes of Ow+Ob in a cohort with four years of evolution of students from Mexico elementary schools and to evaluate its association with socio-demographic factors.

Methods: information comes from a nutritional surveillance system of 52,545 elementary schools, with weight and height measurements from 2,008,474 children from six to eleven years old. A follow-on panel longitudinal analysis was performed from 2015 to 2019 in a dynamic cohort with three measurements. Ow+Ob prevalences were obtained; through a logistic regression with random effects, odds ratios (OR) were calculated, adjusting by sociodemographic characteristics ($p < 0.05$).

Results: between 2015 and 2019, positive OR were observed for Ow+Ob development in 2017-2018 (OR = 1.02) and 2018-2019 (OR = 1.06). Students from the northern and southern regions of the country showed a greater probability of suffering Ow+Ob (OR = 1.58 and 1.64) when compared with the center. Attending to community or indigenous schools was a protective factor (OR = 0.54) whereas attending to a private school increased the risk (OR = 1.75). Adjusted Ow+Ob prevalences showed an accelerated increasing trend in males through all the periods.

Conclusions: in Mexico, obesity in school children is a growing problem related to sociodemographic factors, therefore, urgent actions are needed for its restraining.

Keywords:

Childhood obesity. Nutrition surveillance. Schoolchildren. Obesity. Epidemiology. Overweight.

Resumen

Introducción: México se sitúa dentro de los primeros lugares a nivel mundial en cuanto a sobrepeso y obesidad en escolares, con una prevalencia del 38,2 %.

Objetivo: analizar los cambios de sobrepeso y obesidad (Sob+Ob) durante cuatro años en una cohorte de alumnos de escuelas primarias en México y evaluar su asociación con factores sociodemográficos.

Métodos: la información proviene de un sistema de vigilancia nutricional en escolares. Se realizó un análisis longitudinal de panel con seguimiento a través de una corte dinámica de tres mediciones realizadas entre 2015 y 2019. Se obtuvieron las prevalencias de Sob+Ob a través de una regresión logística con efectos aleatorios y se calcularon razones de momios (OR), ajustando por características sociodemográficas.

Resultados: entre 2015 y 2019 se observaron OR positivos para el desarrollo de Sob+Ob, 2017-2018 (OR = 1,02) y 2018-2019 (OR = 1,06). Los estudiantes de las regiones norte y sur del país mostraron una mayor probabilidad de sufrir Sob+Ob (OR = 1,58 y 1,64) en comparación con el centro. La asistencia a escuelas comunitarias o indígenas fue un factor protector (OR = 0,54), mientras que la asistencia a una escuela privada aumentó el riesgo (OR = 1,75). Las prevalencias ajustadas de Sob+Ob demostraron una tendencia creciente acelerada en los hombres a lo largo de todos los periodos.

Conclusiones: en México, la obesidad en escolares es un problema creciente relacionado con factores sociodemográficos, por lo que se requieren acciones urgentes para su contención.

Palabras clave:

Obesidad infantil. Vigilancia nutricional. Población escolar. Epidemiología. Obesidad. Sobrepeso.

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Correspondence:

Abelardo Ávila Curiel. Division of Nutrition. Instituto Nacional de Ciencias Médicas y Nutrición "Salvador Zubirán". Av. Vasco de Quiroga, 15. Colonia Belisario Domínguez, sección XVI. 14080 Alcaldía Tlalpan. Mexico City, Mexico.
e-mail: abelardo.avilac@incmnsz.mx

INTRODUCTION

Obesity epidemics has become a public health challenge worldwide due to its growing prevalence and its role as a chronic diseases risk factor, mainly type-2 diabetes, cardiovascular diseases (1,2), respiratory disorders, muscle-skeletal conditions, depression and some types of cancer (3-5). This disease presence, at early stages of life, is associated with cardiometabolic alterations (1,2,6,7), abnormal levels of serum lipids (8), high blood pressure and the presence of insulin-resistance markers like HOMA index (1,9,10). COVID-19 pandemics showed how obesity and the set of alterations that comes along with it represent an adverse results risk factor for infectious diseases (11,12).

The Word Health Organization (WHO) has informed that Ow+Ob affects 41 million of children under five years old, 340 million of children and teenagers from five to 19 years old and 1.9 billion of adults of 20+ years old (3). Among the countries members of the Organisation for Economic Co-Operation and Development (OECD), Mexico is the second place in obesity in all its population and it is among the first ones in childhood obesity (6,7).

According to the 2020 National Health and Nutrition Survey (ENSANUT 2020), Ow+Ob prevalence in Mexico has reached 8.4 % in children under five, 38.2 % in school-age children (5-11 years old), 43.8 % in adolescents (12-19 years old) and 74.1 % in adults (13). Between 2006 and 2020, obesity increased across all age groups and displayed a homogenizing evolutionary trend throughout the Mexican population notwithstanding its diverse geographic and sociodemographic characteristics (14).

Previously described ciphers reveal an overwhelming problem: the fast increase and the general damage triggered by the obesity epidemic indicates that, whereas in the country actions like sweetened beverages taxation, new food nutritional labeling, and school guidelines for food selling and distribution have been applied, this has not been enough to address the problem through an efficient public policy (15,16).

A particular example is one state-level program carried out in schools of the Mexican Morelos state aimed to promote the development of healthy life styles. However, prevalences of 15.5 in children under five years old and 26.3 in school-age population were reported; in other words; a difference greater than 10 % in groups between three and 12 years old (17).

Beginning in 2015, the National Registry of Weight and Height (RNPT, by its initials in Spanish) was implemented in Mexico, coordinated by the Division of Nutrition of the National Institute of Medical Sciences and Nutrition "Salvador Zubirán" (INCMNSZ) and the National System for Integral Family Development (SNDIF). It integrated efforts from various sectors, including health and education, at the federal, state and municipal (county like entities) levels. Its objective was to assess the nutritional status of the Mexican population on the basis of anthropometric measurements, specifically, weight and height of Primary School children (18).

Previous publications have described the methodology used by the RNPT, as well as the results it obtained with regard to the pattern of nutritional status (19), particularly obesity, and its relationship to specific geographic and socioeconomic factors. Regarding methodology, it should be noted that anthropometric measurements were registered in a periodical manner through an on-line surveillance system (SIVNE) for children attending elementary-school first to sixth grade. Such publications described in their results sections the nutritional status behavior, focusing mainly in obesity and its association with geographical and socioeconomic factors, emphasizing the transversal results from the 2015-2018 period (20).

The objective of the present study is to describe the trend of overweight and obesity during four years (2015-2019) in a dynamic cohort of children enrolled in Mexican elementary schools. Likewise, it aims to quantify the influence of some sociodemographic factors like sex, geographical factors like the country regions, and the school-related like modality (private, public or indigenous) over overweight and obesity in the children.

METHODS

STUDY DESIGN

A longitudinal analysis was performed in a dynamic cohort of children that attended to public schools and were followed from 2015 to 2019. Having three measurements (one by year) during the cited period of analysis was a requisite for the children to be included in such cohort.

We obtained the data from the RNPT open-access files. This project was approved by the INCMNSZ research and ethics committees. The information pertained to the entire country and was collected through the online platform of the Nutritional Surveillance System for School Children (SIVNE®, by its Spanish initials).

Individuals with previously diagnosed, non-visible health problems or with evident ones were excluded from the study. Inclusion criteria were: children between six and eleven years, evaluated yearly at least in three out of four school years of the study (2015-2019).

TECHNICAL INFORMATION

Ávila et al. described in an RNPT publication (18) the mechanisms used to collect and record the anthropometric measurements of the children. Data on the studied Ow+Ob children included: type of institution, geographic location and socioeconomic level. Concisely, personnel from the Division of Nutrition of INCMNSZ was in charge of advisory, training and anthropometric standardization and equipment usage, as stated by internationally accepted protocols. This schema was replicated in cascade, finally reaching SNDIF community promoters and school teachers who made the measurements. The gathered information was verified by supervisors who were also responsible for keeping contact with the promoters and teachers, in order to provide feedback about the process of obtaining the information.

Weight and height measurements were performed at the schools, and measurements were made on light clothes. A digital SECA 803 (SECA®, Hamburg, Germany) with a total capacity of 150 kg and 100 g of precision was used for weight measurements. Height was obtained in standing position, in contact with the wall, avoiding objects over the head and without shoes. A SECA stadiometer model 206 (SECA®, Hamburg, Germany) was used with a reach of 200 cm and 1 mm precision.

DEFINITION OF OVERWEIGHT AND OBESITY

Based on the child growth standards of the WHO, five variables (date of birth, sex, weight, height and date of measurement) were used to calculate the exact ages and z-scores for the indicator body mass index (BMI) for age (BAZ) (21).

To determine the prevalence of Ow+Ob, the BAZ scores were categorized in accordance with the WHO standards. Overweight was defined as any value between +1 and +1.99 standard deviations (SD) above the median, obesity is greater than 2 standard deviations above the median (21,22). Ow+Ob included both categories grouped.

We cleaned the RNPT data for the anthropometric measurements taken each school year. The inclusion criterion centered on students with weight and height measurements that allowed for estimating the BAZ within a plausibility interval of ± 5 SD and a height for age z-score (HAZ) between -6 and +6.

COVARIATES OF INTEREST

The time variable was defined as school years, in accordance with the academic calendars published by the Ministry of Public Education (SEP, by its Spanish initials). With annual intervals between August 2015 and June 2019, this variable covered the four most recent school years: 2015-2016, 2016-2017, 2017-2018 and 2018-2019.

Sociodemographic characteristics like age or sex were studied using yearly groups of age (six to eleven) for both genres (female or male).

As geographic characteristic, three great country regions were studied (1: north; 2: center; 3: south) based on the ENSANUT classification. Such regions were assigned according to the state in which each school was located.

School modality (1 = public; 2 = private; 3 = community or indigenous) was assigned according to the SEP criteria and the provisions framed in the General Education Law (LGE). Articles 36, 37 and 146 of the LGE establish a code for the classification of schools named CCT (Spanish initials for Work Center Code); this code reflects social, regional and sociocultural groups all over the country. Accordingly, officially sustained schools are divided in: a) public; b) private; and c) community (CONAFE) or indigenous. Due to the fact that community and indigenous schools share the enrollment of similar population (rural, indigenous or immigrant), they were all grouped into a single category.

STATISTICAL ANALYSES

For statistical analyses, STATA version 14 software and version 24 of the Statistical Package for Social Sciences developed by the Social Protection System in Health (SPSS) were used, both under the INCMNSZ, MX institutional license. All analyses used static panel data (xtset) to assess the students and their measurements across the four previously mentioned school years.

For the continuous variables (age, BAZ, HAZ, weight and height), intra- and inter-group statistical distribution were calculated, as well as minimum, maximums, means and standard deviations. For categorical variables (school year, type of school and region), the relative frequencies (xttab) and transition probabilities in the prevalence of Ow+Ob between the first and last year analyzed (xttrans) were estimated. For the latter, we estimated and adjusted the change percentage by dividing it into the initial Ow+Ob percentage.

To estimate de Odds Ratio (OR) of Ow+Ob with 95 % confidence interval (95 % CI), a random effects (RE) panel data analysis and a logistic regression model (re xtlogit model) were constructed adjusting the OR by the previously mentioned sociodemographic characteristics. The Haussman test was applied to differentiate between fixed and random effects (23,24). As the differences in the estimators of the models were not systematic, it was decided to use the random effect method, which allowed for using fixed variables over time, assuming that the individual effects did not correlate with the explanatory variables in the model.

The OR of Ow+Ob and their respective 95 % CI were adjusted for sex, age group, type of school and geographic region. To illustrate the results, predictive margin plots (marginsplot) were generated.

RESULTS

A total of 2,008,474 students from 52,545 schools were analyzed during the four most recent school years, consolidating the data from 6,025,422 anthropometric measurements (Table I, section Ia).

The greatest number of measurements were recorded during the 2017-2018 school year, representing 30.9 % of the total evaluated from 2015 to 2019 (Table I, section Ib). Participation pattern distribution is shown in section II from table I.

The 50.7 % of evaluated population were male (1,018,296) and 49.3 % (990,178) were female. This is a distribution similar to the one reported by the SEP (Table I, section IIIa). The distribution of the 6,025,422 anthropometric measurements was concentrated in more than 45 % in the third and fourth school grades (Table I, section IIIb).

The northern region of the country included 42.8 % of the evaluated population, 26.8 % inhabited the central region and 30.4 % the south, being this last one the only one that shows a similar distribution and without statistically significant differences with the reported by the Education System (Table I, section IIIc).

Table I. Description of patterns and frequency of evaluations by sociodemographic characteristics, descriptive statistics of the characteristics of the students, period 2015-2019

I. General panel information					
a) General panel information				**b) Measurements per school year**	
				School year	**n**	**%**
Students evaluated = 2,008,474				2015-2016	1,144,471	19.0
Total anthropometric measurements = 6,025,422				2016-2017	1,399,768	23.2
				2017-2018	1,860,752	30.9
Schools evaluated = 52,545				2018-2019	1,620,431	26.9
II. Participation patterns by school year, anthropometric measurements registered					
School year				**n**	**%**
2015-2016	**2016-2017**	**2017-2018**	**2018-2019**		
	x	x	x	864,003	43.0
x		x	x	608,706	30.3
x	x	x		388,043	19.3
x	x		x	147,722	7.4
III. Distribution of anthropometric measurements by sociodemographic characteristic and national comparative					
a) Sex		**n = 2,008,474**		**SEP n = 14,137,862**	
		n	**%**	**n**	**%**
Male		1,018,296	50.7	7,199,504	50.9
Female		990,178	49.3	6,938,358	49.1
b) Anthropometric measurements by school grade		**n = 6,025,422**		**SEP n = 14,137,862**	
		n	**%**	**n**	**%**
First	(1st)	617,294	10.2	2,338,484	16.5
Second	(2nd)	831,098	13.8	2,376,958	16.8
Third	(3rd)	1,357,319	22.5	2,368,142	16.8
Fourth	(4th)	1,419,737	23.6	2,360,907	16.7
Fifth	(5th)	1,056,705	17.5	2,347,305	16.6
Sixth	(6th)	743,269	12.3	2,346,066	16.6
c) Geographic region		**n = 2,008,474**		**SEP n = 14,137,862**	
		n	**%**	**n**	**%**
Center		538,548	26.8	6,321,032	44.7
North		860,087	42.8	3,568,857	25.2
South		609,838	30.4	4,247,973	30.0

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Table I (Cont.). Description of patterns and frequency of evaluations by sociodemographic characteristics, descriptive statistics of the characteristics of the students, period 2015-2019

d) Type of school	n = 2,008,474		SEP n = 14,137,862	
	n	%	n	%
Public	1,762,969	87.8	11,885,628	84.1
Private	150,205	7.5	1,350,710	9.6
Indigenous and community	95,298	4.7	901,524	6.4

IV. Descriptive characteristics of the study population, intra and inter groups					
Variable	Mean	sd (overall)	sd (between)	sd (within)	Min-max
z-score (BMI/age)	0.49	1.40	1.23	0.67	(-5.0, 5.0)
Weight (kg)	31.7	10.2	8.9	4.9	(12.6, 106.3)
Height (cm)	131.7	11.2	9.4	6.1	(99.6, 181.3)
Age (years)	8.7	1.5	1.2	0.9	(6.0, 11.6)

SEP: Ministry of Public Education; BMI: body mass index; sd: standard deviation.

In addition, 87.8 % of the population attended public schools, 7.5 % privates and 4.7 % community or indigenous schools, which is representative of the National System of Public Education in Mexico.

The average age was 8.7 ± 1.5 years, with a variation of 1.2 years among individuals and 0.99 years for each student across the four school years. Weight varied between 12 and 106 kg, with a mean of 31.3 kg and variations between 8.9 y 4.9 kg among individuals and school years, respectively. The overall mean and SD observed in height measurements were 131.7 cm and 11.28 cm, respectively. The SD was 9.4 cm among school years and 6.1 cm among individuals (Table I, section IV). The z-scores for the BAZ indicator had a SD of ± 5; the overall mean was 0.49, with a SD of 1.4 and variations of 1.23 and 0.67 among individuals and school years, respectively (Table I, section IV).

TRANSITION PROBABILITIES OF OVERWEIGHT AND OBESITY

Table II shows Ow+Ob prevalences and its change estimation between the initial and final periods. Initial prevalence (ip) of overweight in the study group was 34.1 % and the final (fp) was 37.2 % (Table II, section Ia).

According to the study characteristics, the greater Ow+Ob prevalence was found in males when compared with females (Table II, section Ib) of 36.4 % in ip and 40 % in fp. The raise in the change percentage and change adjusted by sex showed the same order: 3.6 % in males and 2.5 % in females in change percentage and 10.0 % and 7.9 % in the adjusted percentage by gender.

By geographic region, the northern region presented the greater prevalence, with 35.8 % and 38.8 % for ip and fp, respectively (Table II, section Ic). The increases found in adjusted percentage of overweight and obesity were as follows in descendent order: south 11.9 %, center 10.2 %, and north 8.7 % (Table II, section IIc).

Regarding school modality, the greater prevalence was identified in private schools, being 40.6 % in ip and 43.9 % in fp (Table II, section Id).

ODDS RATIO (OR)

All estimates obtained from the model were statistically significant at the 99.99 % confidence level ($p < 0.001$) (Table III).

For students who underwent nutritional monitoring from 2015 to 2019, a positive OR of 2 % for developing Ow+Ob in 2017-2018 and of 6 % in 2018-2019 was observed. The progressive OR increase across the last two school years was estimated compared to the first year analyzed (2015-2016) (Table III, section a).

Students from the northern and southern regions had a higher OR for developing Ow+Ob than those in the central region, with scores of 58 % and 64 %, respectively (Table III, section b).

The evaluated populations in community and indigenous schools showed an OR that suggests a protective effect to develop Ow+Ob (OR = 0.54) for those that attend public schools, while the OR for private schools was 1.75 (Table III, section c).

About sex-age interaction, a directly proportional relation was identified between age and the OR increase to develop Ow+Ob; in females, the OR oscillated between 1.44 and 2.87 whereas in

Table II. Transition probabilities of overweight or obesity and percentage of change from 2015 to 2019, according to sociodemographic characteristics

Characteristics	I. Estimated prevalence of overweight and obesity				II. Percentage of change (%)	
	Initial (ip)		Final (fp)		General change	Change adjusted
	n	%	n	%		
a) Global	685,333	34.1	747,232	37.2	*3.1*	*9.0*
b) Sex						*1*
Male	370,188	36.4	407,093	40.0	*3.6*	*0.0*
Female	315,151	31.8	340,140	34.4	*2.5*	*7.9*
c) Geographic region						
Center	167,655	31.1	185,301	34.4	*3.3*	*10.5*
North	307,877	35.8	333,346	38.8	*3.0*	*8.3*
South	209,992	34.4	228,586	37.5	*3.0*	*8.9*
d) Type of school						
Public	603,565	34.2	225,611	37.4	*3.1*	*9.2*
Private	61,017	40.6	26,813	43.9	*3.3*	*8.2*
Indigenous and community	20,845	21.9	4,802	23.0	*1.2*	*5.3*

Table III. Logistic model with panel data and random effects, to estimate the relative risk of overweight or obesity

n = 6,025,422 Students = 2,008,474		
Category	Overweight and obesity	
	OR	95 % CI
a) School year (ref. 2015-2016)		
2016-2017	0.98*	(0.97, 0.99)
2017-2018	1.02*	(1.01, 1.03)
2018-2019	1.06*	(1.05, 1.08)
b) Region (ref. center)		
North	1.58*	(1.56, 1.61)
South	1.64*	(1.61, 1.66)
c) Type of school (ref. public)		
Private	1.75*	(1.68, 1.83)
Indigenous and community	0.54*	(0.51, 0.57)
d) Sex and age (ref. female, 6 years)		
6 years male	1.45*	(1.42, 1.48)
7 years female	1.44*	(1.41, 1.47)
7 years male	2.05*	(2.01, 2.09)
8 years female	2.08*	(2.04, 2.11)
8 years male	3.11*	(3.05, 3.18)
9 years female	2.62*	(2.57, 2.68)
9 years male	4.48*	(4.39, 4.58)
10 years female	2.89*	(2.83, 2.96)
10 years male	5.71*	(5.58, 5.85)
11 years female	2.87*	(2.80, 2.95)
11 years male	5.86*	(5.70, 6.02)

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Table III (Cont.). Logistic model with panel data and random effects, to estimate the relative risk of overweight or obesity

n = 6,025,422 Students = 2,008,474		
Category	Overweight and obesity	
	OR	95 % CI
e) Region and type of school (ref. public-center)		
North-private	0.86*	(0.82, 0.9)
North-indigenous and community	0.55*	(0.51, 0.6)
South-private	1.28*	(1.2, 1.36)
South-Indigenous and community	0.39*	(0.36, 0.42)
Cons.	0.065*	(0.065, 0.066)

**p < 0.001.*

boys it was between 1.45 and 5.86. In women, the OR fluctuated between 1.44 and 2.87, whereas in men such interval was between 1.45 and 5, suggesting that in men the OR increases more rapidly, related with the age mainly from the nine years onwards (Table III, section d). Section e) of table III shows the interaction between geographical region and school type. Students in private schools in the southern region were unique in showing a greater OR for developing Ow+Ob than those in public schools in the central region (OR = 1.28). In the schools of community and indigenous type from the southern region the OR is 2.56 times lower than in the public schools of the central region.

ADJUSTED RISK OF OVERWEIGHT AND OBESITY BY LOGISTIC REGRESSION

In boys as in girls, the adjusted Ow+Ob probability displayed a general increasing trend between 2015 and 2018 for all time periods and age groups, being greater and remarkably accelerated in 9-11 years old male population (Fig. 1). With the exception of the 2016-2017 school year (Fig. 1B) in which 9-year-old males had the lowest overall adjusted prevalences, the minimum adjusted prevalences were in the 2015-2016 school year for age and sex. Older age represented a major risk factor for developing Ow+Ob. We identified the period between nine and eleven years as the critical stage among school years, with this age span witnessing a marked and accelerated increase in Ow+Ob OR (Fig. 1). Lower figures and a slower increase rate for female than male students at all ages was observed.

Modality and geographic region analyses allow us to distinguish an ascending trend in the overweight and obesity development (Fig. 2), except for private schools from the southern region, which shown a greater OR in the 2015-2016 school year than in the following years.

DISCUSSION

Age and degree of obesity at the diagnose time are basic parameters to evaluate and predict this problem development and their associated comorbidities during childhood, adolescence and adulthood. An analysis of data from the four most recent school years has exposed that the obesity epidemic continues growing in Mexico. This is occurring even though it has been recognized as the principal health problem facing the country and that it was

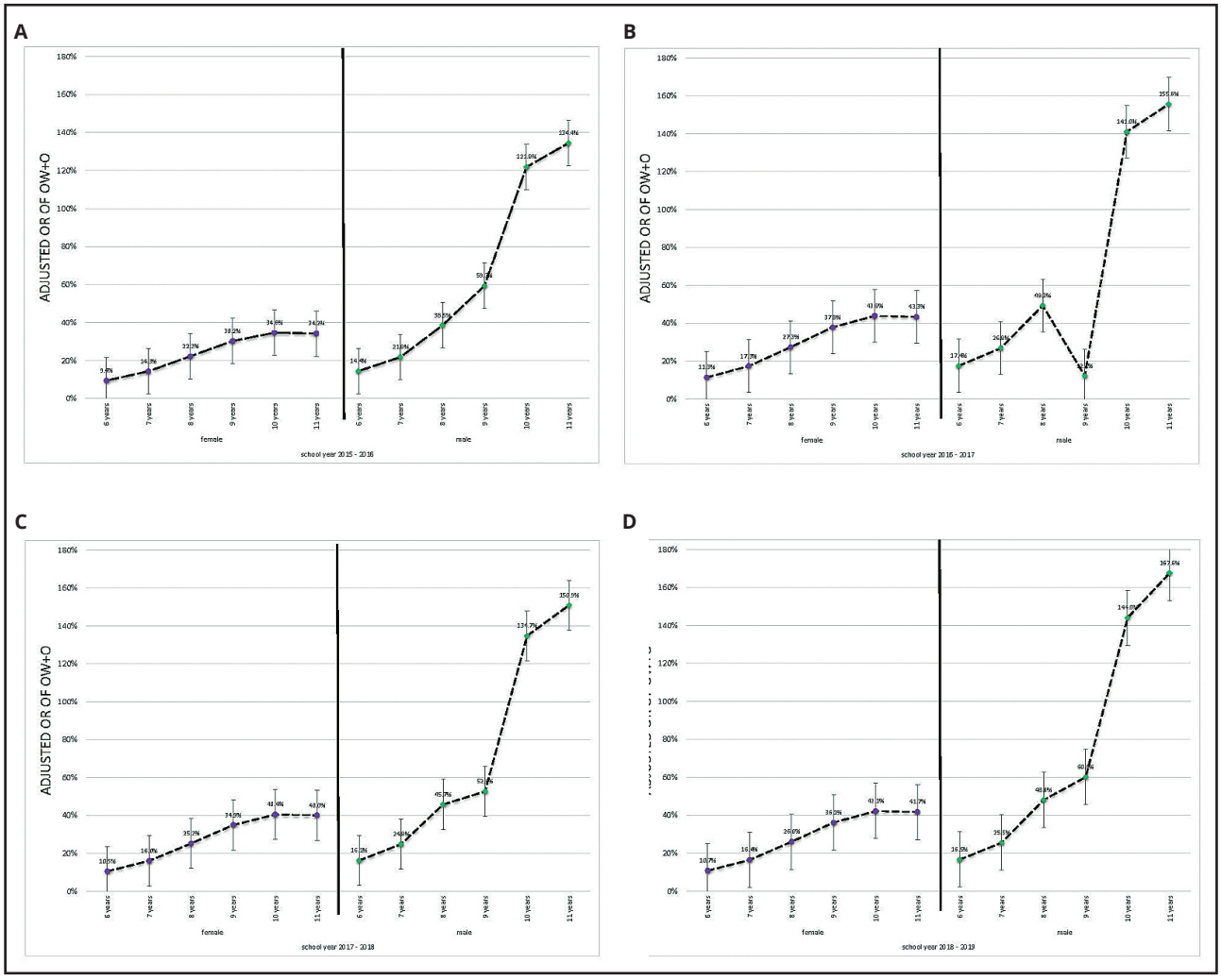

Figure 1.

A. Adjusted OR and CI of overweight or obesity by age and sex, school year 2015-2016. B. Adjusted OR and CI of overweight or obesity by age and sex, school year 2016-2017. C. Adjusted OR and CI of overweight or obesity by age and sex, school year 2017-2018. D. Adjusted OR and CI of overweight or obesity by age and sex, school year 2018-2019.

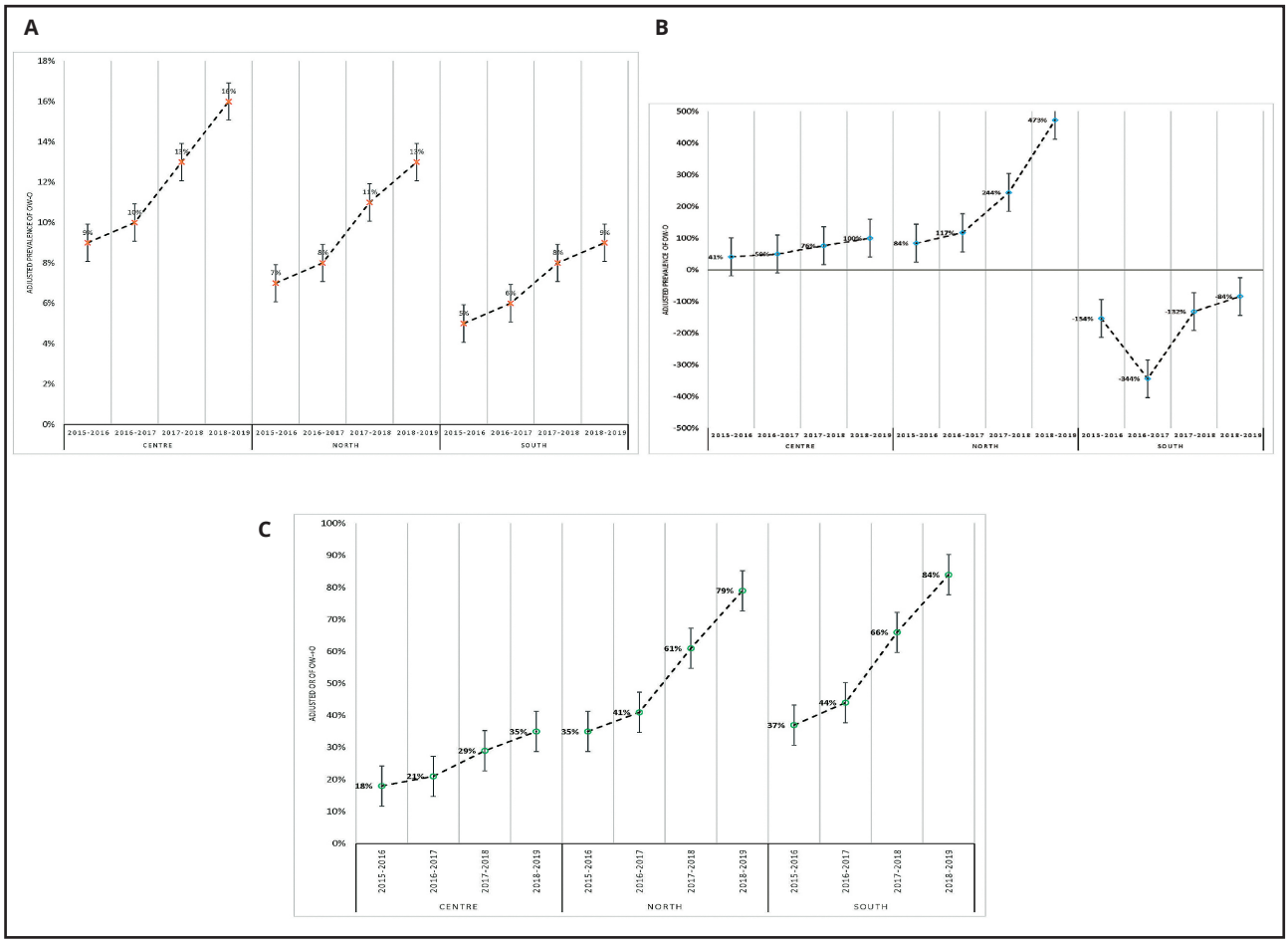

Figure 2.

A. Adjusted OR and CI of overweight or obesity by geographic region and school year, indigenous and community schools. B. Adjusted OR and CI of overweight or obesity by geographic region and school year, public schools. C. Adjusted OR and CI of overweight or obesity by geographic region and school year, private schools.

the subject of a national epidemiological emergency declaration in November 2016, and reaffirmed in February 2018 (25).

By age, the risk for developing Ow+Ob increases rapidly until age ten in females, when a slight decrease takes place, most likely associated with the arrival of puberty. Over the period studied, both male and female students increased their Ow+Ob prevalence at a national level; however, males did so starting from a higher initial level (36.4 *vs* 31.8) and increased at a more rapid rate (10.8 *vs* 7.9 %). These results are in line with those reported by researchers in longitudinal studies conducted in other countries such as the United States (2015) (26), China (2018) (27) and Brazil (2013) (28). Studies with follow-up panel in Europe involving 3,876 students from 18 schools between 2007 and 2010 found similar patterns (29). In Italy, a longitudinal study of 632 students of both sexes reported a constant increase in Ow+Ob, which was greater among males of all ages in the primary school years (30).

The results of the present study are in agreement with trend analyses and reviews that have been conducted about childhood obesity in Latin America and Mexico, and also with other studies in Mexican children about such problem and its relation with the main causes and factors (social, cultural, and intake of energetically dense food) involved in obesity development (14,31,32).

According to our analysis by geographical location, schools in the more economically developed northern region showed the highest prevalence of Ow+Ob and the greatest adjusted OR increase among the periods studied. The association between socioeconomic level and the prevalence of obesity among students has been widely documented over the past decades (33,34). However, this has begun to change in developing countries. Ow+Ob in the student population is now rising most markedly among the disadvantaged population and minority groups suffering high levels of social vulnerability (35,36). Likewise, in Mexico, the greatest increase in the prevalence of Ow+Ob has recently been documented among these groups (14,19).

Ow+Ob prevalences in the center and south of Mexico were lower than in the north; particularly for public and private schools, but all regions showed a similar tendency to increase. Students evaluated in private schools showed greater probability of suffering OW when compared with those of public schools.

Although a great heterogeneity is observed, it is not possible to establish a clear trend in adjusted relative probability of Ow+Ob during the study period. While the students from the northern region had an OR of 0.89, in the south this risk was 1.62. In contrast, this could indicate that in families and in the school environment with better socioeconomic conditions of the most developed regions, modifications that tend to control the Ow+Ob have been produced.

The substantial differences among different social groups in our longitudinal study, as well as those observed in other countries, highlight the existence of diverging patterns contributing to the obesity epidemic among the student population. These differences are rooted in the socioeconomic conditions of the groups. While greater economic capacity may initially result in a higher rate of students with obesity in wealthier families, a diversity of patterns was found, all of them beginning at an early age.

Given the generalized and progressive increase of Ow+Ob in the analyzed panel, the school environment represents a major contributor to this serious public health problem.

Based on evidence from our work and other studies on the subject (16,37,38), we can recommend school years as an appropriate time span for implementing effective interventions to reduce the risk of Ow+Ob. The ineffectiveness of current strategies in addressing or at least containing the obesity epidemic in Mexico and its serious consequences calls for reconsidering the current approach.

An understanding of the dynamics and different patterns generating this epidemic during the school years constitutes the technical basis for deciding what actions needs to be taken, how to gear them towards the appropriate population in a timely manner, and how to evaluate their effectiveness.

To account with epidemiologic intelligence systems, based on nutritional surveillance through the gathering of transversal and longitudinal data, allows the identification of changes in the growth. Particularly SIVNE and RNPT, with the evaluation of the population from the schools and a follow-up during a six-year-period, would be cost-effective in order to implement a public policy that could build a link between health and education sectors participations. Longitudinal follow-up of more than two million students across Mexico represents the principal strength of our study. This was achieved through the participation of 52 thousand schools and the recording of more than six million weight and height measurements. We based our estimates on a panel analysis, which allowed us to incorporate unobservable individual effects and offers a picture of the dynamics of change in Ow+Ob over time.

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