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Metabolic syndrome, physical activity and eating habits in school children of the south of Mexico City.

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Key words: children; obesity; metabolic syndrome.

Abstract. Childhood obesity has increased in recent years, due mainly to the intake of a hypercaloric diet and decreased physical activity. Obese children are more likely to have metabolic syndrome (MS). The objective of this study was to evaluate the prevalence of MS in obese (Ob), overweight (OW) and at risk of overweight (ROW) children, as well as its association with eating habits and physical activity (PA). Anthropometric measurements were made in schoolchildren in Mexico City to detect these conditions. Biochemical tests were made for the diagnosis of MS. A 24-hour dietary anamnesis on food consumption and a physical activity questionnaire were applied. We analyzed the results from 70 children, average age of 11.11 years (± 9 months); 54% were boys and 46% girls. Forty nine percent were at ROW, 43% OW and 8%Ob. Of this sample, 69% had a waist circumference above the 85th percentile. The highest prevalence of altered biochemical parameters were triglycerides and HDL-cholesterol. MS was present in 33% of schoolchildren and risk of MS in 27%. More than half of the children (57%) reported performing PA, of this group only 15% performed PA according to the WHO and presented a lower prevalence of MS, but was not statistically significant. No association was found between reported food consumption and MS. A considerable number of school children (mainly males) presented metabolic alterations, which was also related to a low level of PA. Therefore, it is important to apply preventive health measures from an early age.

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Síndrome metabólico, actividad física y hábitos de alimentación en escolares del sur de la Ciudad de México.

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Palabras clave: niños; obesidad; síndrome metabólico.

Resumen. La obesidad infantil ha incrementado en los últimos años, principalmente por aumento en la dieta hipercalórica y disminución de la actividad física (AF). Los niños que presentan obesidad son más propensos a padecer síndrome metabólico (SM). El objetivo de la investigación fue evaluar la prevalencia de SM en niños con riesgo de sobrepeso (RSP), sobrepeso (SP) y obesidad (Ob), así como su asociación con hábitos alimentarios y AF. Se realizaron medidas antropométricas para detectar RSP, SP y Ob; y pruebas bioquímicas para el diagnóstico de SM en escolares de la Ciudad de México. Se aplicó un recordatorio de 24 h sobre consumo de alimentos y un cuestionario de AF. Se analizaron resultados de 70 niños, con una edad de 11,11 años ± 9 meses, 54% fueron hombres y 46% mujeres. El 49% presentó RSP, el 43% SP, el 8% Ob (sólo hombres) y 69% circunferencia de cintura por arriba del percentil 85th. La mayor prevalencia de parámetros bioquímicos alterados fueron triglicéridos y HDL-c. El 33% de los escolares presentó SM y el 27% riesgo de SM. El 57% reportó realizar AF, de este grupo, sólo el 15% lo realizó de acuerdo a la OMS y fueron los que presentaron menor prevalencia de SM, sin diferencia estadística. No se encontró asociación entre el consumo de alimentos y el SM. Un número considerable de los escolares (principalmente hombres) presentó alteraciones metabólicas, lo que también se relacionó con inactividad física. Por lo tanto, es importante aplicar medidas preventivas de salud desde edades tempranas.

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INTRODUCTION

Throughout the 21st century, one of the most serious public health problems has been childhood obesity. Its prevalence has increased at an alarming rate in recent years (1). Worldwide, the prevalence of overweight and obesity in children aged 5 to 17 has been reported from 5.7% in Pakistan, 17.4% in Venezuela and 36.7% in Spain to more than 40% in Mexico (2, 3). Data from the Half-Way National Health and Nutrition Survey from Mexico 2016 (4) recorded a prevalence of overweight or obesity in 33.7% of boys and 32.8% of girls between 5 and 11 years of age.

Obesity is associated with a large number of health problems, increased morbidity and mortality (5, 6). Children with obesity are more likely to suffer from cardiovascular and metabolic disorders at a younger age, such as dyslipidemias, metabolic syndrome (MS), impaired glucose metabolism, type 2 diabetes mellitus and hypertension, among others, (6-9). The presence of MS has been detected in the pediatric population with a prevalence ranging from 2.4% in the Chinese population to 49% in India (10, 11).

It has been noted that the fundamental cause of overweight and obesity is an energy imbalance between consumed and expended calories, among other factors (12). This is

mainly related to the increased intake of hypercaloric food rich in fat, salt and sugars; and poor in vitamins, minerals, and other micronutrients. In addition, it has been observed that the consumption of sweets and high-energy snacks, large portion sizes and sugary drinks provide calories that are easily assimilated by the body and contribute to an increase of obesity (13, 14). Moreover, it has been documented that a poorly balanced diet is a key risk factor for non-communicable diseases, and the risks associated with this type of feeding begin at childhood and accumulate throughout life (15). Therefore, childhood eating habits are important in forging dietary preferences that have a strong correlation with health.

It has also been reported that low physical activity is a significant factor in the increase in childhood obesity, which has been associated with changes in activity patterns, such as decreased time playing outside the home and an increase in the screen activities (2, 6, 16). In various studies it has been observed that pre-school children, school children, and adolescents with overweight or obesity, and an insufficient level of physical activity (from moderate to vigorous) are associated with a higher incidence of cardiovascular risk factors compared to their counterparts without excess weight and who are sufficiently active (6, 17). In this way, the importance of healthy eating and physical activity as components in the prevention of childhood obesity and the presence of metabolic diseases such as MS is highlighted.

Therefore, the objectives of the present study were to evaluate the prevalence of MS in children at risk of overweight (ROW), overweight (OW) and obese (Ob), as well as its association with eating habits and physical activity (PA) in school children.

SUBJECTS AND METHODS

Participants

A cross-sectional and observational study was carried out. An assessment of BMI was made in fifth and sixth grade school children from five schools in the south of Mexico City (n=398); one hundred seventy-nine children with risk of overweight (ROW), overweight (OW) and obesity (Ob) were detected and invited to participate. However, only 85 participants submitted parental authorization to perform anthropometric measurements and biochemical tests (informed consent). In the end, 15 children did not complete the questionnaire and only 70 children remained for the analyses. The project was approved by the Research and Ethics Committee of the Autonomous Metropolitan University, Xochimilco Campus, Mexico City.

Procedures

The study consisted of two stages: in the first, anthropometric measurements were made to detect at ROW, OW and Ob children. In addition, a 24-hour food consumption and a questionnaire on physical activity habits were applied. In the second stage, children who presented ROW, OW and Ob underwent biochemical tests and blood pressure measurements to obtain the diagnosis of MS.

Anthropometric measurements

For anthropometric measurements, the standardized protocol of the International Society for the Advancement of Kinanthropometry, ISAK, was followed (18). Height, waist circumference (WC) and weight were measured.

For the weight measurement, an electronic scale, brand SECA, model Cursa 818, with an accuracy of 0.1 kg was used. Following anthropometric measurements (weight and height), the body mass index (BMI) was calculated: weight (kg)/height $(m)^2$, which allows school children to be classified according to their BMI for age, using WHO criteria (19). To calculate the Z score for BMI/Age, the Anthro Plus (Version 3.1, 2010) was used. WC was measured using an anthropometric tape (SECA 201) at the midpoint between the last rib and the iliac crest.

Diagnosis of metabolic syndrome

Using Alere Cholestech LDX equipment, biochemical tests were carried out, only in children who presented ROW, OW and Ob. Capillary blood was obtained after a 12-hour fast. The second drop was taken with the microtube unit (full) and then the blood was placed on a Cholestech plate. Five minutes later, the concentrations of high-density cholesterol (HDL-c), total cholesterol (Total Chol), low-density cholesterol (LDL-c), triglycerides (TG) and glucose (GLU) were obtained.

The blood pressure (BP) was taken twice, 15 minutes after the school children were sitting at rest and with arm supported. The indirect auscultatory method was used with a calibrated aneroid sphygmomanometer.

For the diagnosis of MS, the modified ATP III criteria for adolescents were applied, corrected by Dávalos (20) for the Mexican school population, taking into account the age and sex of each individual (Table I). MS was diagnosed having altered 3 of the variables and risk of MS (RMS) was diagnosed having altered 2 variables.

Food consumption

Food consumption was analyzed by means of a 24-hour dietary recall. Taking into consideration the recommendations of the Mexican System of Foods Equivalent (21) on average consumption of food groups, kilocalories, percentages and grams of proteins, carbohydrates and lipids per day were obtained. In addition, the number of portions of different food groups: fruits, vegetables, cereals (with and without fat), animal origin foods (AOF) of very low, low, moderate and high fat content, fats and sugars were calculated. In order to have a comparison parameter on an adequate energy intake, the recommendations of nutrient intake for Mexican children of 11 and 12 years old were used (approximately 2250 kcal/day) (22, 23).

Physical activity habits

Similarly, the information on physical activity (PA) obtained referred to number of sessions per week, minutes of PA per week, and approximate time spent performing this activity. In order to ascertain whether the study population was within the appropriate parameters, WHO criteria were used, in which it is recommended that children aged from 5 to 17 perform 60 minutes of physical activity daily (15).

Statistical analysis

The distribution of each variable was analyzed using the Kolmogorov-Smirnov

TABLE I
ATP III CRITERIA MODIFIED FOR ADOLESCENTS.

Criteria	Adolescents, ATPIII modified by Dávalos (20)
Triglycerides (TG)	≥95th percentile: 130 mg/dL (10-18 years for both sexes)
HDL – Cholesterol (HDL)	≤5th percentile: 35 mg/dL for both sexes.
Blood Pressure (BP)	≥90th percentile: age and sex specific
SBP	Female 12 years old >122
	Male 12 years old> 123
DBP	Both sexes 12 years old >78
Glycemia (GLU)	≥ 100 mg/dL
Waist Circumference (WC)	≥85th percentile: age and sex specific
	Female 12 years old 79.2 cm
	Male 12 years old 77.9 cm

SBP: systolic blood pressure; DBP: diastolic blood pressure.

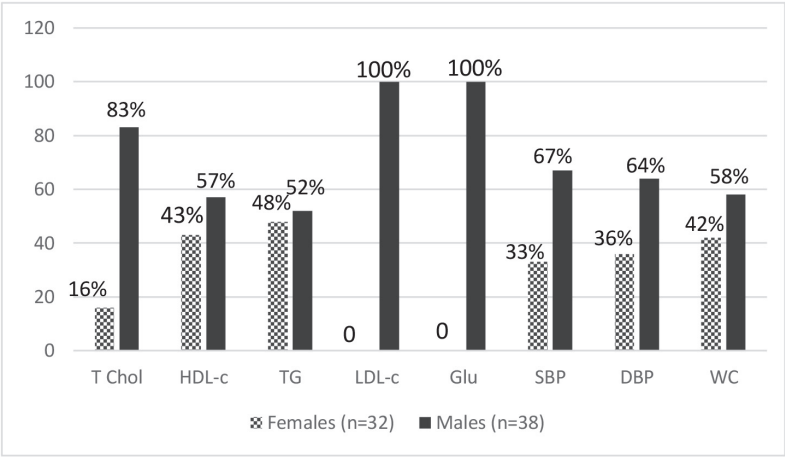
test. Logarithmic transformation was performed to approximate normality in those variables that showed a non-parametric distribution. The results are shown as average and standard deviation, and the median using inter-quartile range (IQR). The comparison between 2 groups was carried out using the t-Student test. The comparison between 3 groups was made by means of one-way ANOVA, followed by Bonferroni´s post hoc test when ANOVA was significant. The analysis of categorical variables was performed with contingency tables using the Chi square test. A value of $p<0.05$ was considered significant, using the statistical program SPSS (Version 20.).

RESULTS

The children had an average age of 11.11 years (± 9 months); of which 54% (n=38) were males and 46% (n=32) were females. Of the total number of children, 49% (n=34) had ROW, 43% (n=30) were OW and 8% (n=6) were Ob. Boys had a higher prevalence of OW (60%, n=18) than girls, and girls at ROW (59%, n=20). Only males presented obesity.

Biochemical variables were analyzed, and it was observed that 33% of the children had low HDL-c, 48% elevated levels of TG, 9% of Total Chol, 4% of LDL-c, and 1% of GLU. Additionally, 9% of the children had elevated systolic blood pressure (SBP) and 34% diastolic blood pressure (DBP); 69% of them had WC above normal. When the analysis was performed by sex, it was observed that most of the males presented the biochemical variables and a WC over acceptable limits, that is, 83% of them had Total Chol. ≥150 mg/dL, 52% triglycerides ≥130 mg/dL, 57% HDL-c <35 mg/dL, as well as elevated levels of LDL-c and GLU, without being these significant data with respect to those of women. In addition, more than half of the boys had high SBP and DBP (67% and 64%, respectively) (Fig. 1). When comparing the averages according to sex, males presented higher WC values than females ($p<0.012$) (Table II).

When performing the diagnosis of MS according to the modified criteria of ATP III for Mexican adolescents, it was noted that 40% (n=28) of the children did not have MS, 27% (n=19) had risk of metabolic syndrome (RMS) and 33% (n=23) MS. When the analysis was performed by sex, it was observed that girls had a higher prevalence of RSM (58%) compared to boys (42%), while boys had a higher prevalence of MS (70%) than girls (30%), with no statistical significance ($p<0.173$) (Fig. 2).



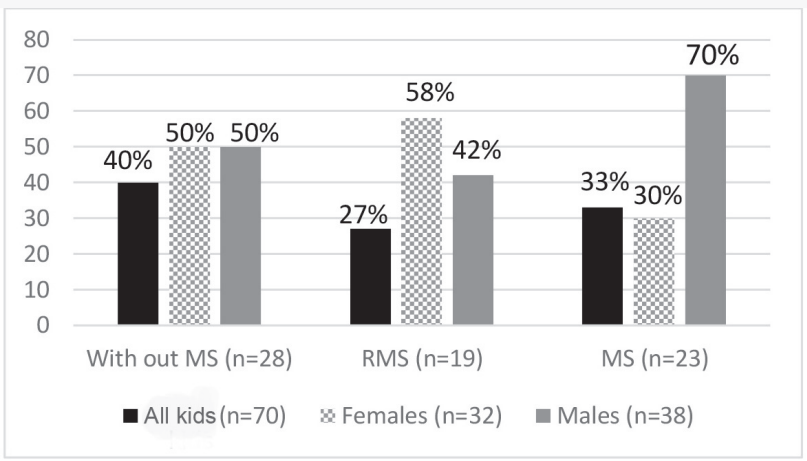
T Chol: total cholesterol; HDL-c: high-density lipoprotein cholesterol; TG: triglycerides; Glu: glucose; LDL: Low-density cholesterol; SBP: systolic blood pressure; DBP: diastolic blood pressure. WC: waist circumference.

Fig. 1. Percentage of biochemical and anthropometric parameters of children who presented alterations by sex.

TABLE II
DISTRIBUTION OF BIOCHEMICAL PARAMETERS ACCORDING TO SEX IN THE STUDY GROUP.

Parameters (n=70)	All kids (n=70)	Girls (n=32)	Boys (n=38)	p
WC (cm)	80.9 ±8.6	78.2 ±6.9	83.2 ±9.3*	0.012
TG (mg/dL)	130 (85-171)	132 (85-171)	123.5 (84-170.2)	0.948
HDL-c (mg/dL)	38.1±10	39.6 ±10.3	36.8 ±9.7	0.248
Glu (mg/dL)	84.1 ±6.3	84.2 ±6.6	84 ±6.1	0.885
LDL-c (mg/dL)	87.7 ±25.9	84.9 ±23.2	90.2 ±28	0.399
T Chol (mg/dL)	155.1±32.7	152.9 ±26.7	157 ±37.2	0.599
SBP (mmHg)	100 (95-110)	100 (90-110)	105 (100-110)	0.202
DBP (mmHg)	70 (60-80)	65 (60-80)	70 (61.2-80)	0.136

WC: waist circumference; TG: triglycerides; HDL-c: high-density lipoprotein cholesterol; Glu: glucose; LDLc: Low-density cholesterol; T Chol: total cholesterol; SBP: systolic blood pressure; DBP: diastolic blood pressure. Data are presented as mean ± SD or inter-quartile range (IQR). Student t test was done to compare girls *vs* boys. * Statistically significant difference by sex ($p<0.05$).



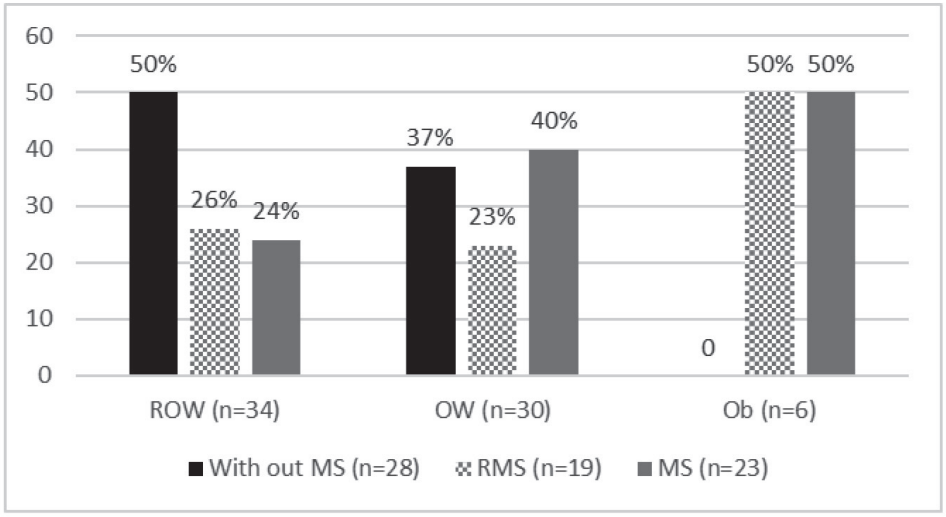
MS: metabolic syndrome; RMS: risk of metabolic syndrome. Pearson´s Chi square ($p<0.173$).

Fig. 2. Relationship of diagnosis of metabolic syndrome of the entire study group and according to sex.

When analyzing the MS in relation to BMI, it was observed that the prevalence of MS increased according to BMI increase: children with ROW had a prevalence of 24% and children with obesity 50%, without statistically significance ($p<0.161$) (Fig. 3).

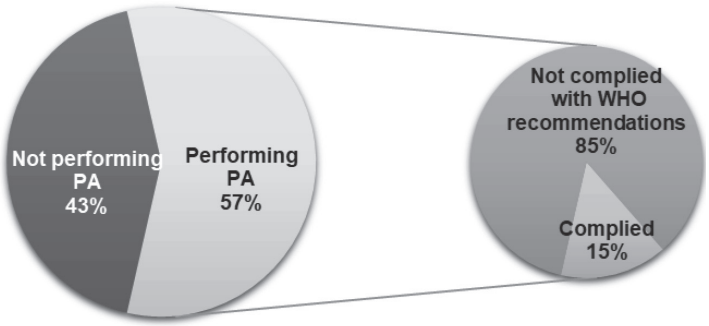
Regarding physical activity (PA), it was shown that 57% of the school children reported performing some type of physical activity, most of which were males (69%). On average, the time spent performing the activity was 30 (IQR 60-120) mins/day, 3 times per week. Most of the children started doing physical activity 12 (IQR 2-48) weeks before. It should be noted that only 15% (n=6) of the children who performed PA complied with WHO recommendations, 80% (n=5) of which were males and 20% (n=1) females (Fig. 4).

In analyzing PA according to BMI, it was found that 50% of the participants with



ROW: risk of overweight; OW: overweight; Ob: obesity; MS: metabolic syndrome; RMS: risk of metabolic syndrome. Pearson´s Chi square (p<0.161).

Fig. 3. Prevalence of metabolic syndrome according to BMI.



PA: physical activity; WHO: World Health Organization.

Fig. 4. Physical activity and compliance with the recommendation proposed by WHO.

ROW complied with the recommendation, followed by those with OW (33%) and Ob (17%), (p<0.365). It was found that children without MS complied more with the WHO recommendation of PA (44%), followed by children with RMS (28%) and MS (28%) (p<0.951), without statistically significance (Table III).

Food consumption

Regarding food consumption, it was calculated that the study population on average consumed 1699.6 ± 560.7 kcal/day, of which 63g (50.5-74) were protein, 57.8 ± 23g of lipids and 224.3 ± 90g of carbohydrates (CH), which were divided into 4 meals —3 main and 1 snack.

When the reported consumption of total kilocalories and grams of macronutrients per day was analyzed in relation to BMI, it was found that children with ROW were those who consumed the most kilocalories and children with Ob the least, without the data being statistically significant (p<0.256).

TABLE III
RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND METABOLIC SYNDROME IN THE STUDY GROUP.

	Diagnosis of Metabolic Syndrome			
Do you comply with the recommendation of A.F.?	Without MS (n=18)	Risk MS (n=11)	MS (n=11)	p
No (n=34)	50%	25%	25%	0.920
Yes (n=6)	44%	28%	28%	0.951

F.A: physical activity; MS: metabolic syndrome. Pearson´s Chi square was done to compare yes or no comply with the recommendation of A.F. according to diagnosis of MS.

TABLE IV
DISTRIBUTION OF ENERGY CONSUMPTION ACCORDING TO THE BMI OF THE STUDY GROUP.

	ROW (n=34)	OW (n=29)	Ob (n=5)	p	Recommendation
Energy (kcal/day)	1800.4 ± 512.1	1628.7±559	1426±835.2	0.256	2250[a]
Carbohydrates (g/day)	234.5±87 (53%)	217.7±91.3 (54%)	193.4±111.4 (57%)	0.561	309.3 (55%)[b]
Lipids (g/day)	63±22.6 (32%)	54±22 (30%)	44±26.1 (29%)	0.119	62.5 (25%)[b]
Proteins (g/day)	66.5 (56.7-77.7) (15%)	62 (48-72.5) (16%)	46 (30-98) (14%)	0.182	112.5 (20%)[b]

ROW: risk of overweight; OW: overweight; Ob: obesity. Data are presented in media ± SD or median and interquartile range (IQR). One-way ANOVA was done to compare energy and macronutriments according to ROW, OW and Ob. [a] Bourges et al (22); [b] Berdanier et al. (23).

The distribution of macronutrients by percentage was within recommendations (22, 23); however, regarding g/day, values below the recommendation were observed (Table IV). When food consumption was analyzed in relation to SM, no differences were found among the 3 groups of participants in total kilocalories ($p<0.951$), protein consumption ($p<0.988$), lipids ($p<0.257$), and HC ($p<0.432$).

Regarding portions of the various food groups that the participants reported eating, it was observed that the consumption of fruits and vegetables was very low, 1 and 0.5 portions per day, respectively, and there was no consumption of legumes, nor animal origin foods (AOF) of very low, low or high fat content. From AOF, a moderate fat intake of 2.7 (2.7-3.3) portions per day was reported. In relation to the consumption of cereals, it was observed that school children consumed more non-fat cereals (7 [4-10] portions/day) than fat cereals (2 [2-3] portions/day), although some school children reported the consumption of up to 11 portions of cereals with fat. Regarding milk consumption, they reported on average 1 (1-2) glass a day, oil 3 (2-4) and sugar 3 (1-6) portions/day, although some children reported sugar consumption between 10 and 20 portions per day (data not shown).

When analyzing the portions of the various food groups in relation to BMI, no significant difference was found; however, in relation to MS, participants with MS consumed more AOF (with moderate fat content) than those without MS ($p<0.039$, data not shown).

Finally, total energy intake and macronutrient consumption were related to PA (those who performed or did not perform PA and those who complied or did not comply with WHO recommendations). It was found that children who complied with the recommendations consumed more total kilocalories and carbohydrates than those who did not comply with the recommendations ($p<0.050$ and $p<0.042$, respectively). No difference was found between groups that performed or did not perform PA (Table V).

DISCUSSION

The objective of the present study was to analyze the relationship among BMI, MS, eating habits and physical activity in school children. According to the results, we have observed that most at ROW, OW and Ob children presented alterations in biochemical variables, as well as elevated BP (both systolic and diastolic) and WC. In addition, it was noted that the prevalence of MS increased according to the BMI, which indicates that excess weight in children and adolescents could be associated with unfavorable patterns of metabolic markers during childhood. Previously, it has been reported that children with obesity tend to remain obese in adulthood (40% of children who are obese at age 7 and 70% at age 12 will become obese adults), and have a higher probability of suffering cardiovascular and metabolic disorders at earlier ages (6, 24-26).

In the present study it was found that in the group of school children, 33% had MS and 27% RMS. The results agree with data obtained in a study conducted by Vucovic et al. (2015) (27) on 254 Serbian children between 4.6-10 years of age, where a prevalence of 31.2% of MS was found in obese participants. Additionally, in India, in an analysis of obese adolescents between 10 and 18 years of age, the prevalence of MS was 49% (11). However, in a study of 16,872 Chinese adolescents between 10 and 17 years of age, a prevalence of only 2.4% was observed, boys showing a higher prevalence than girls (2.7 vs 2%, respectively) (10). The wide variability of the data may be explained by the different variables, such as, on the one hand, the lack of consensus on the definition of MS in children and adolescents given that at present, different criteria and cut-off points have been used for diagnosis (28). On the other hand, it is important to consider other factors, such as the dietary habits, physical activity, culture, socioeconomic status and age of the individuals included in the studies.

TABLE V
INGESTION OF MACRONUTRIENTS ACCORDING TO PHYSICAL ACTIVITY AND WHO RECOMMENDATIONS OF THE STUDY GROUP.

	Do you do physical activity?			Does it meet the recommendation of FA according to the WHO?		
	Yes (n=44)	No (n=24)	p	Yes (n=4)	No (n=35)	p
Energy (Kcal/day)	1686.5 ± 565.8	1723.8 ± 562.4	0.795	2245.7 ± 970.2	1649.1 507.1*	0.050
Carbohydrates (g/day)	225.3 ± 98.5 53.5%	222.4 ± 73.8 52%	0.889	324.5 ± 168.3 58%	217 ± 87.5* 52%	0.042
Lipids (g/day)	56.6 ± 19.9 30.5%	60 ± 28 32%	0.566	65 ± 9.7 26.04%	56.8 ± 21.2 31%	0.458
Proteins (g/day)	63 (48.5-72) 15%	64.5 (56-79.2) 15%	0.502	61.5 (52.2-138.2) 11%	65 (50-72) 16%	0.257

Kcal: Kilocalories. Data are presented as media ± SD or median and inter-quartile range (IQR). Student t test was done to compare yes vs no. * Statistically significant difference $p<0.05$.

MS is composed of a cluster of cardiovascular risk factors (hypertension, altered glucose metabolism, dyslipidemia, and abdominal obesity). Although many attempts have been made to define MS in the pediatric population, to date there is no a consensus definition (29). However, there are a series of classifications by which a diagnosis can be supported, the WHO, the International Diabetes Federation, and the National Cholesterol Education Program (ATP III), among others (28).

On the other hand, physical inactivity is another problem related to excess weight, which is negatively associated with high-density cholesterol (HDL-c), high blood pressure and high cholesterol concentration (6, 15).

In the present study, slightly more than half of the children (57%) reported performing some type of physical activity with a duration of 30 min/day, three times a week, data that are inferior than those reported by ANIBES (Anthropometry, Intake and Energy Balance), which found that the population of 9-12 years performed approximately 100 min per day of FA (30, 31).

In addition, only 15% of pediatric population complied with the WHO recommendations, data that are similar to those reported by the Half-Way National Health and Nutrition Survey from Mexico (2016), who observed that 17.2% of the children complied with the recommendation (4). It was observed that participants with obesity complied to a lesser degree with the WHO recommendations than children with ROW and OW (that is, 60 minutes of moderate or vigorous activity daily in children and adolescents from 7 to 17 years old as a measure to prevent obesity and its associated comorbidities) (15, 32). On the contrary, although not in a statistically significant way, it was found that participants who did not have MS were the ones who mostly complied with WHO recommendations. This suggests that, although they present excess weight (ROW, OW or Ob), physical activity would seem to be a preventative factor in metabolic alterations. Similar data have been reported in other studies, where the increase in physical activity levels has been correlated with a lower incidence of cardiovascular risk factors (33).

Furthermore, physical inactivity has been identified as the fourth risk factor in global mortality (6, 34). Blüher *et al.* (2014) concluded that in obese children an increase in physical activity over a 12-month period of standardized exercise was associated with improved metabolic control, as well as with beneficial changes in inflammatory markers and leptin (35).

In the present study, children with RMS and MS were those who to a lesser extent complied with the PA recommendation. For that reason, the relationship between physical inactivity and the presence of metabolic disorders was observed. These data in general coincide with other studies that have shown that children and adolescents with overweight or obesity, and with insufficient levels of moderate or vigorous physical activity are at significantly higher risk of presenting cardiometabolic alterations compared to those who are sufficiently active (6, 17).

In relation to the duration of physical activity, recommended by the WHO, we observed that only 15% of schoolchildren met these criteria, of which 20% were girls and 80% boys. Similar data on low physical activity have been reported in Perú, where it was found that less than 1% of children met the recommendations for their age (36). Likewise, it has been observed that girls on average performed less physical activity than boys (6, 36).

On the other hand, sufficient dietary energy intake is important for the growth and development of children and adolescents, as well as for covering the daily energy expenditure. However, excess energy intake is associated with the development of overweight and obesity (37). In this way, it has been mentioned that dietary factors are clearly associated with childhood obesity (38).

In the present study, it was observed that schoolchildren on average consumed 1700 kcal, 63g (14.8%) were proteins, 57.8 (30.6%) lipids and 224.3 (52.7%) carbohydrates, which is below the recommendations for nutrient intake and kcal/day for the Mexican population (22, 23). The children who complied with the PA recommendation had a higher energy and CH consumption compared to those who did not comply with the recommendation (2245.7 vs 1649.1 kcal, 58% vs 52%, respectively). Similar results have been reported by Córdova *et al.* (39), who observed that athletic children had higher energy consumption (2385 ± 165 kcal) than sedentary children (2176 ± 193 kcal). However, in relation to the distribution of macronutrients, the authors found that athletic children had lower CH intake and higher lipid and protein intake than sedentary children, unlike the present investigation, where children who complied with the recommendation had higher CH intake (there was no difference in the consumption of other macronutrients).

We also found that children with OW or Ob reported a lower caloric intake than the group at ROW, data similar to an investigation conducted in Malaysia, where children with obesity reported significantly lower energy intake than children in the other weight categories (40). This suggests that obese individuals evaluate their intake subjectively, probably because they are not aware of portion sizes; therefore, it has been concluded that OW or Ob children frequently underestimate their caloric intake (41 22).

Taking into account the increasing prevalence of overweight or obesity in children, changes in lifestyle related to physical activity and eating habits are very important from an early age given that at this stage in life, behaviors are acquired that can persist throughout life. (42). These timely changes could prevent problems related to obesity in adulthood (41).

To conclude, it is worth mentioning that in the present study it could be observed that a considerable number of at ROW, OW and Ob school children had metabolic alterations, reported low levels of physical activity and unhealthy eating habits. Boys had greater alterations in metabolic parameters than girls.

Children who performed physical activity had a lower prevalence of MS. In addition, it was found that the caloric intake of the children was below the recommendation for the Mexican population. Although the distribution of the macronutrients was within acceptable limits, in grams per day the participants did not meet the recommendations. It should be noted that children with Ob reported the lowest intake.

Taking the above into consideration, it is important to prevent health problems from an early age in order to have adults with a lower prevalence of chronic degenerative diseases in the future.

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